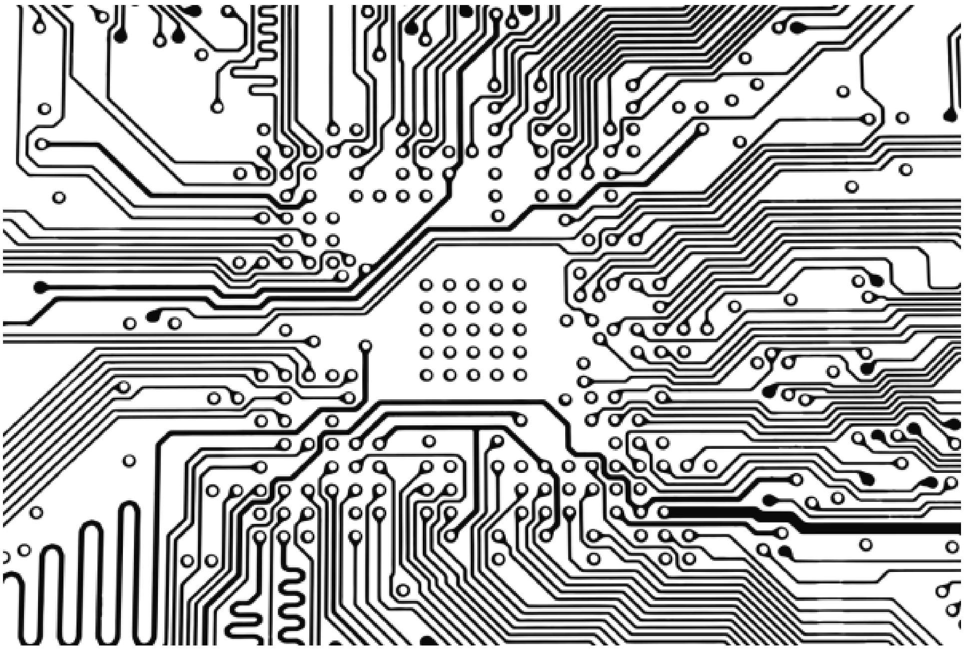
Владимирский государственный университет

Г. Н. ЗАМАРАЕВА

COMPUTER AIDED DESIGN IN ELECTRONICS ENGINEERING

Учебно-практическое пособие
по английскому языку



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имени Александра Григорьевича и Николая Григорьевича Столетовых»

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Цель учебного пособия – обучение различным видам речевой деятельности на английском языке в профессиональной сфере радиоэлектроники.

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ПРЕДИСЛОВИЕ

Современную радиоэлектронику применяют в системах радиосвязи, радиовещании и телевидении, радиолокации и радионавигации, радиоуправлении и радиотелеметрии, в медицине и биологии, промышленности и космических проектах; современные бытовые приборы также работают благодаря развитию радиоэлектроники, которое требует общения ученых и специалистов разных стран. Английский язык жизненно необходим тем, кто решил связать свою жизнь со сферой радиоэлектроники.

Учебное пособие предназначено для развития навыков чтения специальной литературы и профессионального общения на английском языке, содержит тексты, взятые из современных английских и американских книг, журналов, газет, учебников, проспектов и сайтов британских и американских университетов, профессиональных сообществ и компаний. В конце каждого раздела даны слова, значение которых нельзя понять из контекста.

В пособие включены грамматические упражнения, тематически связанные с текстами, лексическими и коммуникативными заданиями, предназначенные для повторения и закрепления навыков употребления видовременных форм английского глагола в страдательном залоге, изучения неличных форм глагола, модальных глаголов и др. В конце издания есть грамматический справочник.

Пособие также содержит тексты для дополнительного чтения, перевода и развития навыков устной речи и реферирования.

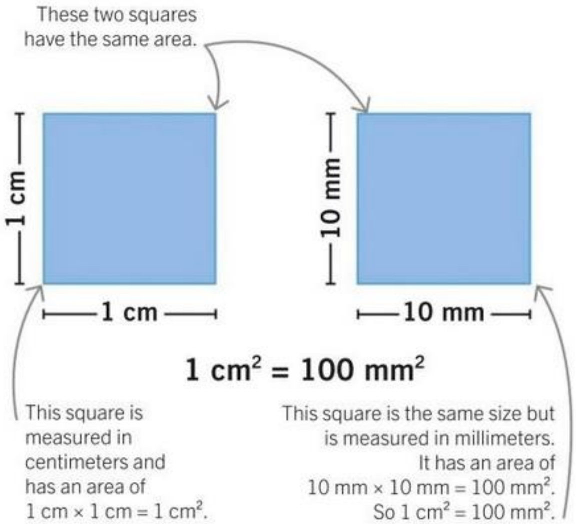
Unit I
INTRODUCTION TO MODERN ELECTRONICS
Grammar (Passive Voice)

1. ***Try to guess what is described in the dictionary article:***

word-forming element meaning "small in size or extent, microscopic; magnifying;" in science indicating a unit one millionth of the unit it is prefixed to, e.g. ...meter, ...second, ...phone, etc.

Do you know any words with this word-forming element? Write them down, and then check with your groupmates.

2. ***Do you know how big or how much it is? Can you read it?***



100 mm^2
1,000,000,000
1 micrometer
60 micrometers
Nanometer

3. ***Can you match the parts of the sentences in two columns? To do it you have to know prefixes:***

Nano – one billionth; micro – one millionth; milli – a thousandth; centi – one hundredth; deci – one tenth; deca/deka – ten times the stated unit; hector – a hundred times the stated unit; kilo – 1,000 times the stated unit.

1 nanometer (nm)	is 1,000,000,000,000 nm (one trillion)
1 micrometer (μm)	is one-billionth of a meter.
1 millimeter (mm)	is 0.01 kilometers.
1 centimeter (cm)	is one-millionth of a meter.
1 decimeter (dm)	is one-thousandth of a meter.
1 meter (m)	is equal to 100 million nanometers.
1 decameter/dekameter (dam/dkm)	is equal to 10,000,000 nanometers.
1 hectometer (hm)	is the basic unit of length in the SI system of units, defined to be the distance light travels through a vacuum in exactly 1/299792458 seconds.
1 kilometer (km)	is a unit of length equal to 100 meters.

4. Read the text to complete the table and add some examples:

Modern microelectronic circuits are used in

household appliances	to cook (*oven*), to wash, …
vehicles and transportation systems	to …
	to communicate
	to entertain ourselves

Introduction

The subject of this book is modern electronics, a field that has come to be known as microelectronics. Microelectronics refers to the **integrated-circuit** (IC) technology that at the time of this writing is **capable of** producing circuits that contain billions of **components** in a small piece of **silicon** (known as a **silicon chip**) whose area is **roughly** 100 mm^2. One such microelectronic circuit is a complete digital computer, which is known, **appropriately**, as a microcomputer or, more generally, a microprocessor.

The microelectronic circuits you will learn to **design** are used in almost every **device** we **encounter** in our daily lives: in the **appliances** we use in our homes; in the **vehicles** and transportation systems we use to travel; in the cellphones we use to **communicate**; in the medical **equipment** we need to care for our health; in the computers we use to do our work; and in the audio and video systems, the gaming **consoles** and televisions, and the multitude of other digital devices we use to entertain ourselves. Indeed, it is difficult to **conceive of** modern life without microelectronic circuits.

In this book we will read about electronic devices that can be used **singly** (in the design of **discrete circuits**) or as components of an integrated-circuit (IC) chip. We will read about the design and analysis of interconnections of these devices, which form discrete and integrated circuits of varying complexity and perform a wide variety of functions. We will also learn about available IC chips and their application in the design of electronic systems.

The purpose of this book is to introduce some basic concepts and terminology. In particular, we will learn about signals and about one of the most important signal-processing functions electronic circuits are designed to perform: **signal amplification**.

We will then look at circuit representations or models for **linear amplifier**s. These models will be used in subsequent chapters in the design and analysis of actual **amplifier circuits**.

5. ***Read the text again to answer the questions:***
   What does microelectronics refer to?
   How many components do circuits contain?
   What devices contain microelectronic circuits?

6. ***Read the text and say what devices could be described as microelectronic devices and what the size of microchips is.***

How small are microelectronic devices?

The "micro" stands for micrometer, which is one-millionth of a meter. (An **average** human hair is around 60 micrometers thick.) Microchips themselves aren't that tiny, but if you stuck one under a microscope, it would have **features** and **regions** at that micrometer scale. Today, some chips even have features on the nanometer scale. A nanometer is one-billionth of a meter!

In 2021, the tech industry **hailed** the improved capacity of a **supercomputing chip** the size of an iPad, along with the creation of the world's smallest single-chip system the size of a **dust mite**. Despite the dramatic size difference, both are microelectronic devices, because both have micrometer-scale features.

The microchips found in everyday computers and smartphones range from the size of a fingernail to a postage stamp.

7. Decide if the statements are true or false. Correct the false ones.

1) Microelectronics as well as electronics refers to the integrated-circuit (IC) technology.
2) One microelectronic circuit is a complete digital computer.
3) We do not use microelectronic circuits in devices we encounter in our daily lives.
4) It is impossible to conceive of modern life without microelectronic circuits.
5) Electronic devices can be used singly or as components of an integrated-circuit (IC) chip.
6) Electronic circuits are designed to amplify signals.
7) An average human hair is around 60-millionth of a meter thick.
8) All microchips are tiny.

8. *Match the terms and their definitions.*

An integrated circuit	means to make or draw plans for something.
A silicon chip	is a drawing or set of drawings showing how a building or product is to be made and how it will work and look.
Design	is a very small electronic circuit that consists of a lot of small parts made on a piece of semiconducting material.
To perform	is the total amount that can be contained or produced.
To draw	is a small piece of silicon that is used in computers, calculators, and other electronic devices.
Capacity	means to do an action or piece of work.

9. *It's interesting to know.*

How Much is a BILLION?

Astronomers estimate that there are more than 100 BILLION stars in our Milky Way Galaxy. That's a lot of stars!

A "billion" is a very large number. Exactly how much is a billion? To help you visualize this number, you can use your power of estimation. It's simple: start with a small amount and work your way out.

Let's try it with oranges. Imagine…

10 oranges would fill a large salad bowl.

One thousand oranges would fill a pick up truck.

One million oranges would fill a swimming pool.

One billion oranges would fill a stadium to the brim!

How to Write Big Numbers

Writing big numbers can take a lot of space.

If you write a 1 followed by three zeros, you get 1,000 = one thousand. If you write a 1 followed by six zeros, you get 1,000,000 = one million. If you write a 1 followed by nine zeros, you get 1,000,000,000 = one billion!

That's a lot of zeros! Astronomers often deal with even larger numbers such as a trillion (12 zeros) and a quadrillion (15 zeros). When astronomers write these really, really big numbers, they use a shorthand called scientific notation. For example, instead of writing out a billion using nine zeros (like this: 1,000,000,000), they write it like this: 10^9. The little number 9 means there are nine zeros.

10. Passive Voice (See Appendix 2, Grammar Reference 1). Find and translate the sentences where the Passive Voice is used in the texts above.

11. Transform the sentences using the Passive Voice.

1) We use various digital devices to communicate, to do our work, to entertain ourselves. 2) These devices perform a wide variety of functions. 3) Electronic circuits perform signal amplification. 4) They stuck a microchip under a microscope. 5) In 2021, the tech industry hailed the improved capacity of a supercomputing chip the size of an iPad. 6) They use a shorthand called scientific notation. 7) Guglielmo Marconi pioneered the development of the wireless telegraph in 1896. 8) We generally use nanometers to measure microscopic things, both man-made and natural, such as molecules, atoms, and the tiny components used in computer processors. 9) The microelectronics industry will play a major role.

Vocabulary

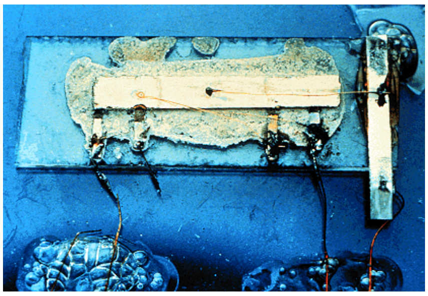
amplifier circuit	схема усилителя, контур усилителя
appliances	бытовая техника
appropriately	соответственно
average	обычный, средний, среднестатистический
capable of	в состоянии, способен
communicate	передавать информацию, общаться
components	детали, комплектующие
conceive of	представлять
console	игровая приставка, пульт
design	проект, разрабатывать, проектировать
device	аппарат, устройство
discrete circuits	дискретная схема
dust mite	пылевой клещ
encounter	столкнуться
equipment	оборудование
feature	элемент, компонент
hail	объявлять
integrated-circuit	интегральная схема, микросхема
linear amplifier	линейный усилитель
region	узел, область
roughly	приблизительно
signal amplification	усиление сигнала
silicon	кремний
silicon chip	кремниевый чип, кремниевая микросхема
singly	отдельно, по отдельности
supercomputing chip	микросхема суперкомпьютера
vehicle	автомобиль, транспортное средство

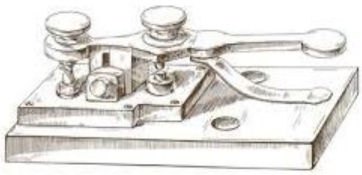
Unit II
HISTORY OF ELECTRONICS
Grammar (Passive Voice)

1. Match the words / word combinations and the pictures.

1) vacuum tube
2) transistor
3) integrated cicuit
4) diode
5) telegraph
6) radio
7) television






2. Match the words/word combinations and their definitions.

1) conductor	a)a substance that allows heat or electricity to go through it
2) diode	b)a device shaped like a box with a screen that receives electrical signals and changes them into moving images and sound, or the method or business of sending images and sound by electrical signals
3) electron	c)a hollow glass cylinder containing a positive electrode and a negative electrode between which is conducted in a full or partial vacuum
4) radio	d)a space from which most or all of the matter has been removed, or where there is little or no matter

5)	telegraph	e) a device that controls an electric current so that it can only flow in one direction
6)	television	f) a small electrical device containing a semiconductor, used in televisions, radios, etc. to control or increase an electric current
7)	transistor	g) an extremely small piece of matter with a negative electrical charge
8)	vacuum	h) a piece of electronic equipment used for listening to radio broadcasts
9)	vacuum tube	i) a method of sending and receiving messages by electrical or radio signals, or the special equipment used for this purpose

3. Can you read these dates?

1833, 1904, 1906, 1896, 1901, 1918, in the 1920s, in 1935, from 1920 to 1935, until 1947, in 1927, by the mid-1950s, in 1947, in 1952, throughout the 1950s, by 1961, by the mid-1970s.

4. Read the text on the history of electronics and complete the table:

Date	Personality	Discovery / Invention / Development
1833	*Thomas Alva Edison*	*conduction (Edison effect)*
	Guglielmo Marconi	
		long-distance radio communication
1904		
	Lee De Forest	
		wireless telegraph
	Edwin Armstrong	
		radio broadcasting grew astronomically
	Edwin Armstrong	
1920 - 1935		
1920s		
1927		

		television became widely available
by the mid-1950s		
		the transistor was invented
1952		
		transistors were mass produced on single wafers and cut apart
By 1961		
		analog ICs, large-scale integration (LSI), and very-large-scale integration (VLSI)

Electronics
History

The history of electronics is a story of the twentieth century and three key components – the vacuum tube, the transistor, and the integrated circuit. In 1883, Thomas Alva Edison discovered that electrons will flow from one metal conductor to another through a vacuum. This discovery of conduction became known as the Edison effect. In 1904, John Fleming applied the Edison effect in inventing a two-element electron tube called a diode, and Lee De Forest followed in 1906 with the three-element tube, the triode. These vacuum tubes were the devices that made **manipulation** of electrical energy possible so it could be **amplified** and **transmitted**.

The first **applications** of electron tubes were in radio communications. Guglielmo Marconi pioneered the development of the **wireless** telegraph in 1896 and long-distance radio communication in 1901. Early radio consisted of either radio telegraphy (the transmission of Morse code signals) or radio telephony (voice messages). Both relied on the triode and made rapid advances thanks to armed forces communications during World War I. Early radio transmitters, telephones, and telegraph used **high-voltage sparks** to make waves and sound. Vacuum tubes strengthened weak audio signals and allowed these signals to be **superimposed** on radio waves. In 1918, Edwin Armstrong invented the "**super-heterodyne receiver**" that could select among radio signals or stations and could receive distant signals. Radio broadcasting grew astronomically in the 1920s as a direct result. Armstrong also invented **wide-band frequency modulation** (FM) in 1935; only AM or **amplitude modulation** had been used from 1920 to 1935.

Communications technology was able to make huge advances before World War II as more specialized tubes were made for many applications. Radio as the primary form of education and entertainment was soon challenged by television, which was invented in the 1920s but didn't become widely available until 1947. Bell Laboratories publicly **unveiled** the television in 1927, and its first forms were electromechanical. When an electronic system was proved superior, Bell Labs engineers introduced the **cathode ray picture tube** and color television. But Vladimir Zworykin, an engineer with the Radio Corporation of America (RCA), is considered the "father of the television" because of his inventions, the picture tube and the **iconoscope camera tube**.

Development of the television as an electronic device benefitted from many improvements made to radar during World War II. Radar was the product of studies by a number of scientists in Britain of the reflection of radio waves. An acronym for *RA*dio *D*etection *A*nd *R*anging, radar measures the distance and direction to an object using echoes of radio microwaves. It is used for aircraft and ship detection, control of weapons firing, navigation, and other forms of **surveillance**. **Circuitry**, video, pulse technology, and microwave transmission improved in the wartime effort and were adopted immediately by the television industry. By the mid-1950s, television had **surpassed** radio for home use and entertainment.

After the war, electron tubes were used to develop the first computers, but they were impractical because of the sizes of the electronic components. In 1947, the transistor was invented by a team of engineers from Bell Laboratories. John Bardeen, Walter Brattain, and William Shockley received a Nobel prize for their creation, but few could **envision** how quickly and dramatically the transistor would change the world. The transistor functions like the vacuum tube, but it is tiny by comparison, weighs less, consumes less power, is much more reliable, and is cheaper to manufacture with its combination of metal contacts and semiconductor materials.

The concept of the integrated circuit was proposed in 1952 by Geoffrey W. A. Dummer, a British electronics expert with the Royal Radar Establishment. Throughout the 1950s, transistors were mass produced on **single wafers** and **cut apart**. The total semiconductor circuit was a simple step away from this; it combined transistors and diodes (active devices) and **capacitors** and **resistors** (passive devices) on a **planar unit** or **chip**. The semiconductor industry and the silicon integrated circuit (SIC) **evolved** simultaneously at Texas Instruments and Fairchild Semiconductor Company. By 1961, integrated circuits were in full production at a number of firms, and designs of equipment changed rapidly and in several directions to adapt to the technology. Bipolar transistors and digital integrated circuits were made first, but analog ICs, large-scale integration (LSI), and very-large-scale integration (VLSI) followed by the mid-1970s. VLSI consists of thousands of circuits with on-and-off switches or gates between them on a single chip. Microcomputers, medical equipment, video cameras, and communication satellites are only examples of devices made possible by integrated circuits.

5. Read the text again and answer the questions:

1. When did Thomas Alva Edison discover conduction? What do they call Edison effect? 2. What did John Fleming invent? 3. What did Lee De Forest develop? 4. What did these inventions make possible? 5. Where were electron tubes first applied? 6. What did Guglielmo Marconi develop? 7. What caused rapid advances in radio telegraphy and radio telephony? 8. What did early radio transmitters, telephones, and telegraph use to make waves and sound? 9. What strengthened weak audio signals? 10. Who invented a device to select among radio signals or stations and receive distant signals? What was the result of this invention? 11. What did Armstrong invent in 1935? 12. Why was communications technology able to make huge advances before World War II? 13. When was the television invented? When did it become available? 14. Who introduced cathode ray picture tube and color television? Who is considered the "father of the

television"? Why? 15. What does radar stand for? Where was it developed? How is it used? 16. What improvements were adopted by the television industry? When had television surpassed radio? In what areas? 17. Why were electron tubes impractical in the development of computers? What are the advantages of transistors when compared with electron tubes? 18. What did semiconductor circuit combine? 19. When were integrated circuits in full production? Did designs of equipment change rapidly? 20. What types of integrated circuits were made first and what other types were they followed by the mid1970s? 21. What devices are made possible by integrated circuits?

6. ***Read the text again and make a summary. Use the patterns in Appendix 3 or those that follow:***
   The text *is about / devoted to / related to / deals with …*
   This is of great interest for those who study …
   The author draws our attention to the fact that …
   There are some good and interesting examples illustrating …
   To sum up / In conclusion I'd like to say that …

7. ***Make a presentation on the history of electronics. Use additional information (See the references or surf the internet to get further information).***

8. ***It's interesting to know.***

Interesting Facts

Here are some interesting facts, incidents, memorable events and little-known facts from the lives of scientists…

Intel Inside

Intel was founded by Robert Noyce, along with Gordon Moore and Andrew Grove. The **headquarters** building is named 'Robert Noyce Building.'

While presently almost every PC has at least one Intel chip, Noyce thought 'it seemed **ridiculous'** to build a home computer.

Noyce later recalled, “Long before Apple, one of our engineers came to me with the suggestion that Intel ought to build a computer for the home. And I asked him, ‘**What the heck** would anyone want a computer for in his home?’”

Silicon transistors? Impossible!

On May 10, 1954, at the Institute of Radio Engineers (IRE) National Conference on **airborne electronics** in Dayton, Ohio, there was a serious discussion and the speakers were of the general opinion that the silicon transistor was **a long way off** or probably impossible. Taking out those tiny little devices from his coat pocket, Teal announced, “Contrary to what my colleagues have told you about the **bleak prospects** for silicon transistors, I happen to have a few of them here in my pocket.” Gordon Teal and his team created the first commercial silicon transistor by April 14, 1954.
https://www.electronicsforu.com/special/cool-stuff-misc/interesting-facts

9. ***Complete the sentences with the correct form of the verb in brackets (Passive or Active).***

1. Electronics’ actual history … (begin) with the invention of vacuum diode by J.A. Fleming, in 1897; and, after that, a vacuum triode … (implement) by Lee De Forest to amplify electrical signals. 2. The transistor era … (begin) with the junction transistor invention in 1948. Even though this particular invention … (get) a Nobel Prize, yet it … later … (replace) with a bulky vacuum tube. 3. The JFETS and MOSFETs … (develop) from 1951 to 1958. 4. Digital integrated circuits were yet another robust IC development that … (change) the overall architecture of computers. These ICs … (develop) with Transistor-transistor logic (TTL), integrated injection logic (I2L), and emitter-coupled logic (ECL) technologies. 5. All these radical changes in all these components … (lead) to the introduction of microprocessors in 1969 by Intel. Soon after, the analog integrated circuits … (develop) that introduced an operational amplifier for analog signal processing.

Vocabulary

airborne electronics	бортовая электроника
a long way off	далекая перспектива
amplify	усиливать
amplitude modulation	амплитудная модуляция
application	применение
benefit from	извлекать пользу
bleak prospects	мрачные перспективы
capacitor	конденсатор, емкость
cathode ray	катодный луч, электронный пучок
chip	микросхема, интегральная схема
circuitry	электрическая схема, компоновка схемы
cut apart	порезать
envision	представлять себе
evolve	испускать
frequency modulation	частотная модуляция
headquarters	штаб-квартира
high-voltage sparks	высоковольтный импульс
iconoscope camera tube	трубка иконоскопной телевизионной камеры
manipulation	управление
picture tube	кинескоп
planar unit	плоский (планарный) блок
radar	радар, радиолокационное устройство
reflection	отражение
resistor	сопротивление, катушка сопротивления
ridiculous	смехотворный, невероятный

single wafer	полупроводниковая пластина
super-heterodyne receiver	гетеродинный приемник сверхвысокой производительности
superimpose	наложение
surpass	превзойти, перегнать
surveillance	наблюдение
transmit	передавать
unveil	впервые показать продемонстрировать
what the heck	Что за ерунда!
wide-band	широкий диапазон частот, широкополосный
wireless	беспроводной

Unit III
INTEGRATED CIRCUITS
Grammar (Modal Verbs)

1. ***Can you guess the meaning of the words that follow?***

Individual, experiment, patent, component, basic electronic part, transistor, diode, resistor, electricity, supercomputer, electric signal.

2. ***Modal Verbs (See Grammar Reference 2). Read and translate the sentences. Pay attention to modal verbs.***

1. We must first understand them as a whole. 2. Their makeup should not be too far beyond your grasp. 3. We are able to send information throughout the device. 4. The engineer must be very careful when soldering. 5. You should probably at least understand how we went from basic circuitry to the supercomputers. 6. It can only flow in one direction. 7. These components can consist of a wide range of electronic parts. 8. This can be dangerous, causing fires or even small explosions. 9. The copper connections cannot cross one another. 10. Silicon-based life may not be entirely science fiction. 11. They may be close on the Periodic Table of Elements but silicon and carbon are different chemical beasts.

3. ***Read the text and answer the questions.***

When was the first basic integrated circuit constructed?
What did both companies attempt to do?
Why did the companies have legal battles? How long?
What did the companies agree in 1969?
What are integrated circuits similar to in terms of their performance?
What are basic electronic parts of integrated circuits?

What is an integrated circuit?

An integrated circuit is one great step up from a **printed circuit**, they have even played a large role in the development of many of the **technological wonders** that **populate** the world today. But what is an integrated circuit? How does it **apply** to you? How has their development changed your life? To answer these questions, we must first understand them as a whole.

How was it invented?

The first basic integrated circuit was constructed **by hand** by Jack Kilby on September 12th 1958. A similarly gifted individual called Robert Noyce started experimenting using a different approach. Both companies attempted to **patent** this idea in 1958 and 1959. For around 10 years, both companies had **legal battles** over who has developed the integrated circuit. In 1969 they agreed to share the idea and have shared the **acclaim** and **awards** that have come from it after this point. These have included **inductions** into **the National Inventors Hall of Fame**[1] and a shared Nobel Prize in Physics accreditation. As their use developed over the years, far greater amounts of components were placed onto the chip. In 1965, Gordon Moore stated that the number of components on a chip doubled every one to two years. This has continued even to the present day. This shows the **incredible value** and **longevity** of the integrated circuit **long-term**.

How do integrated circuits work?

Integrated circuits, or chips, simply perform as a very **powerful** electric circuit. Their **makeup** should not be too **far beyond** your **grasp**, as they are constructed from basic electronic parts. The technology that makes your computer able to run everything from Microsoft Word to Half-Life is just run by connected transistors, diodes, capacitors, and resistors. The transistors act as **amplifiers** for all of our **household electronics**, while the resistors focus on tuning back the effect.

Capacitors role in integrated circuits

Capacitors allow electricity to be **stored** and **released** in varying amounts for special effects, and the diode works to **cut off** electricity. Through these simple changes to electric current, we are able to send information throughout the device to make everything work correctly.

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[1] the National Inventors Hall of Fame Национальный зал славы изобретателей — американская некоммерческая организация, созданная в 1973 году для поощрения людей, внесших значительный вклад в прогресс технологий.

4. ***Read the text and decide if the statement are true or false. Correct the false ones.***
1. Jack Kilby was the only person to make the first basic integrated circuit.
2. Two companies immediately agreed to share the idea and have shared the acclaim and awards including Nobel Prize.
3. The use of integrated circuits developed over the years and the number of the components on a chip is decreasing.
4. Nevertheless one can understand the construction as there are basic electronic parts used.
5. Every electronic device has transistors, diodes, capacitors, and resistors.

5. ***Match the parts of the sentences.***

An integrated circuit	means to get the official legal right to make or sell an invention.
A printed circuit	is an electronic device that strengthens the electric signal used to carry sound.
To patent	is a very small electronic circuit that consists of a lot of small parts made on a piece of semiconducting material.
A chip	is a device that controls an electric current so that it can only flow in one direction.
A transistor	is a set of electrical connections made by thin lines of metal instead of wires, used in computers and other electronic equipment.
A diode	is a small electrical device containing a semiconductor, used in televisions, radios, etc. to control or increase an electric current.
A capacitor	is a very small piece of semiconductor, especially in a computer, that contains extremely small electronic circuits and devices, and can perform particular operations.

A resistor	is a part of an electrical circuit designed to produce a particular amount of resistance to the flow of current.
An amplifier	is a device that collects and stores electricity, and is an important part of electronic equipment such as televisions and radios.

6. ***Read the text and get ready to summarize it. Use the following patterns:*** *The text deals with … The author states that … There are some interesting examples illustrating … It should be realized that… The author arrives at the conclusion …*

The history of integrated circuits

Now that you understand the basics, you should probably at least understand how we went from basic circuitry in the 1950s to the supercomputers of the 21st century. The 1950s saw a very important change in the field of electronic parts. Transistors were invented to replace the **bulky** and ineffective vacuum tubes that were once necessary for circuits. This let smaller electronics be practical and possible, since you finally didn't need your own **power plant** to **run advancing technologies**.

Integrated circuits in computers

The chips were still **held back** by old circuitry though. Computers require the electric signals to flow quickly between the different parts. Old methods of production meant that the chips were just too large to actually be fast enough for practical computing. A new method for building a faster and smaller chip had to be found.

The answer came through the development of the integrated circuit by Jack Kilby. He was just a new researcher **left alone** in the Texas Instruments laboratory while several of his colleagues were on vacation. While alone, he **came up with** a radical new way to actually **craft chips**. The different parts could just be made out of one block of a **semi-conductive material**.

Metal connections would then just connect the different pieces together. Gone were the days of **unwieldy** and ineffective **wires** for transmitting information from point A to point B. This technique allowed for smaller integrated circuits to be made **later on**, which **ultimately** led to the development of the microprocessor.

Future integrated circuit development

In the end, this simple development opened the door for years of **refinement** that have led us to our current position. One integrated circuit led to another until it ended with the **mind boggling** speed of chips of today. Hundreds of millions of basic electronic parts are now able to **fit on** one chip that is no larger than an average fingernail.

It's pretty amazing – especially when you consider that this chip **powers your life** through its advanced methods of calculation that **paved the way** for **the information age**.

7. ***Match the English words and word combinations with their Russian equivalents. Two of them have the same equivalent.***

A) time delay; output voltages; input voltage; line graph; ceramics; plastics; operational amplifiers; variable voltages; op-amp.

B) линейный график, линейная диаграмма; выходное напряжение, напряжение на выходе; пластмасса; время задержки, задержка; регулируемое напряжение; входное напряжение, операционный усилитель; напряжение на входе; керамика.

8. ***Read the text to answer the questions:***
   1. *What makes a gadget function?*
   2. *What components do ICs include?*
   3. *What materials are used to produce ICs?*
   4. *Why are analog ICs termed linear?*
   5. *What do the most popular and common types of ICs include?*
   6. *What are the functions of voltage regulators and operational amplifiers?*
   7. *What are digital integrated circuits composed of?*
   8. *What increases the ability of an IC to perform logical operations*
   9. *What is the importance of ICs?*

Printed & Integrated circuits

What makes a gadget function?

Ever wonder what goes into the making of your new gadget? Electronic circuits are composed of individual transistors formed with resistors and diodes on a piece of silicon. The individual components are commonly connected using aluminum "wires" on the chip's surface. This process results in the formation of IC, or integrated circuits. These ICs contain millions or just several transistors. ICs are responsible for the creation of video games, computers, digital watches, and most of today's high tech gadgets.

The workings of an integrated circuit

ICs are usually grouped in two: analog/linear and digital/logic. But most **sophisticated** ICs combine **digital** and **analog** functions in forming a chip. As examples, digital chips sometimes include an analog/**linear voltage regulator**, while some analog chips include built-in **digital counter**. Combining integrated circuits is usually done to improve performance or add new features to a product such as giving counters time delays which are usually possible only with timers. These chips come in numerous different **packages**. In the present, the most popular and usual kinds are varieties of the DIP (**Dual In-line Package**). Ceramics or plastics are the usual components of standard DIPs with pins ranging from four to 100. Metals are also used for making DIPs but most manufacturers **opt** to replace these with more cost-effective plastic DIPs.

Separate integrated circuits

Despite the popularity of combination ICs and DIPs, there are still demands for separate integrated circuits. Analog ICs' output and input voltage levels vary greatly in a broad spectrum. But despite these variations, output voltages are still directly proportional to input voltages which form a line graph. This is why analog ICs are termed linear. There are different types of analog ICs but the most popular and common types include voltage regulators and operational amplifiers. Voltage regulators **alter** voltages applied to inputs into variable voltages. Standard voltage regulators have excess transistors for the chips to manage driving loads that need added power than a standard op-amp is capable of. Most of these voltage regulators have metal **tabs** or include metal packaging to aid in radiating excessive heat out of the chips. Special linear ICs that include op-amps, like **phase-locked loops** and audio amplifiers, are made for TV, radio, computers, and telephone communications. Operational amplifiers are often considered as the most useful and versatile. Although their designs are basically intended for doing mathematical operations, they also amplify differences in voltages and signals of the inputs.

Digital integrated circuits

Digital integrated circuits are composed of "gates" regardless of the complexity of designs. These gates function like switches that turn on and off. A digital IC contains several gates and an IC with two input gates is usually referred as a **logic gate**. Increase in inputs and gates increase the ability of an IC to perform logical operations. As a result, digital ICs are often used in information transfers and exchanges. ICs are just small components of average devices like computers. But these devices rely on the efficiency of these ICs to function.

9. ***Get ready with the presentation on the topic of the unit.***

Vocabulary

acclaim	хвалебные отзывы
alter	инвертировать (фазы электропитания)
amplifier	усилитель
analog	аналоговый
apply	распространяться на
awards	награды
be far beyond one's grasp	выходить за рамки понимания
built-in digital counter	встроенный счетчик
bulky	громоздкий
by hand	вручную
come up with	придумать, разработать
craft chips	создавать, изготавливать
cut off	отключать
digital	цифровой
Dual In-line Package	корпус ДИП – микросхема с двухрядным расположением выводов
fit on	подогнать, насадить
hold back	сдерживать, замедлять, тормозить
household electronics	бытовая электронная аппаратура
incredible value	поразительное значение, потрясающая ценность
inductions	вступление
later on	впоследствии, позднее
left alone	предоставленный сам себе
legal battles	судебная тяжба
linear	линейный
logic gate	логическая схема
long term	в долгосрочной перспективе
longevity	долговечность
makeup	структура, состав
mind boggling	ошеломляющий, поразительный
packages	оборудование, установка, пакет услуг

patent	патент, запатентовать
pave the way for	подготовить почву для
phase-locked loops	система ФАПЧ – система фазовой автоматической подстройки частоты
populate	наполнять, заполнять
power plant	электростанция, двигатель
powerful	мощный
power	вдохновлять, поддерживать
printed circuit	печатная плата
refinement	усовершенствование
release	высвобождать, выпускать
run	выполнять, запускать на выполнение
run advancing technologies	запускать развивающиеся технологии
semi-conductive material	полупроводниковые материалы
sophisticated	сложный
store	аккумулировать, хранить
tab	плоский разъем
technological wonder	чудо техники
the information age	век информации
ultimately	в конечном счете
unwieldy	громоздкий, неудобный
voltage regulator	регулятор напряжения
wires	провода

Unit IV
THE BASICS OF PRINTED CIRCUIT BOARDS: DESIGN, COMPONENTS AND CONSTRUCTION
(Grammar: The Infinitive)

1. ***In this unit you will come across the abbreviation PCB. Can you guess what PCB stands for?***

2. ***Match the English words and word combinations in A with their Russian equivalents in B.***

A) 1) PCB design, components and construction; 2) electronic device; 3) set up of a PCB; 4) operate; 5) reinforced with glass; 6) copper lines and pads; 7) multi layered PCB; 8) electrical charge; 9) situated systematically on the board; 10) double sided PCB; 11) additional layer; 12) original design.

B) a) Многослойная печатная плата; проектирование, b) основные компоненты и структура печатной платы; c) первоначальная, исходная конструкция; d) усиленный стеклом; e) медные электрические цепи и контактные столбики; f) работать; g) электронное устройство; h) электрический заряд; i) двухсторонняя печатная плата; j) принципиальное устройство печатной платы; k) упорядоченно размещенные на плате; l) добавочный слой.

3. ***The Infinitive (See Appendix 2, Grammar Reference 3). Before reading the text read and translate the sentences. Pay attention to the infinitive.***

1. Here are the basics of **PCB** design, components and construction to give you a better idea of how your electronics operate. 2. These copper lines (known as **traces**) allow electrical charge to **<u>flow through</u>** the PCB. 3. They're **<u>colour coded</u>** to determine their value. 4. **<u>Light emitting diode lights up</u>** when current flows through it, and will only allow current to flow in one direction. 5. an engineer will choose to use either the **surface mount** method or the **through-hole** method to attach the components.

6. The PCB is ready to be used in a device. 7. Not all these students will go on to work as engineers. 8. The skills learnt can be applied to a variety of different jobs and roles. 9. The advent of digital computers has allowed laborious design calculations to be performed rapidly. 10. We must work with others to achieve our outcomes. 11. To succeed we all need to be aware of the latest technology. 12. Who knows who else could be added to this list in the future? 13. To see an idea finally go into motion is one of the most gratifying experiences. 14. Hyatt was the first to take out patents for this discovery. 15. Various units or segments must be able to move.

4. ***Read the text. Three sentences have been removed from the text. Choose from the sentences A – D the one which best fits each gap. There is one extra sentence which you do not need to use.***

A) These components can consist of a wide range of electronic parts.
B) But these devices rely on the efficiency of these ICs to function.
C) However, in the single sided boards one side is reserved for the copper trace and the other side houses the components.
D) This can be dangerous, causing fires or even small explosions.

The Basic Set Up of a PCB

As you probably know, printed circuit boards are pretty **ubiquitous** in the world of electronics. You will probably find one in the devices that you use every day. However, people often use these electronic devices without considering or understanding the technology behind them. Here are the basics of **PCB** design, components and construction to give you a better idea of how your electronics operate.

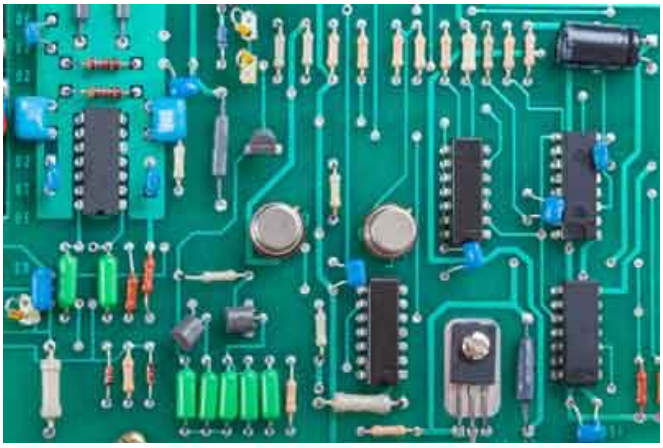
In its simplest form, a PCB is a plastic board reinforced with glass. Attached to this board are **copper lines** and **pads**, which connect together, cut from a copper layer. These copper lines (known as **traces**) allow electrical charge to **flow through** the PCB, **providing power** to the different components that are situated systematically on the board. The copper traces **function in the place** of wires, guiding the electricity to the correct destination.

The Layers of a PCB

The simplest PCBs are **<u>single sided boards</u>** (one copper **layer**). However, the copper traces can also be **install**ed on both sides of the board, creating a double sided PCB. They become more and more complex as additional layers are added to the original design. These new layers have their own copper trace formations. The copper connections cannot cross one another without the **path** of the electrical charge being **compromise**d, so multi layered PCBs become necessary for **advanced** electronics. ***1) …***

On top of the copper layer sits the **<u>solder mask</u>** and the **silkscreen**. The solder mask is what makes the PCB its recognisable green colour. This has the function of **insulating** the copper from any metal parts that might **accidently** come into contact with it. However, parts of the metal will remain exposed so that they can be **solder**ed to. The silkscreen sits on top of the solder mask again. This has letters and numbers drawn on it which make the **assembly** of the PCB easier for the engineer (or the hobbyist!).

The Components



If the copper traces behave like the skeleton of the PCB, acting as its basic structure – then the components are the **vital organs**. Each one has a different function. They give the circuit the unique qualities that make it fit for its **intended purpose**. Depending on the device or electronic item a PCB is designed for, different components will be needed for different circuits. ***2) …*** Some common PCB components include:

Battery: provides the **voltage** to the circuit.

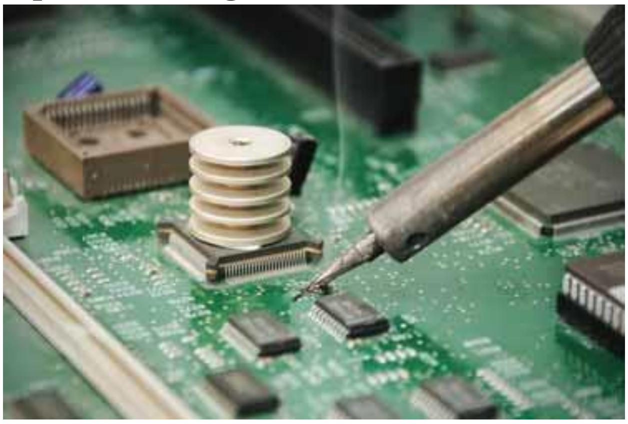
Resistors: control the electric current as it passes through them. They're **<u>colour coded</u>** to determine their value.

LEDs: <u>light emitting diode</u>. **<u>Lights up</u>** when current flows through it, and will only allow current to flow in one direction.

Transistor: amplifies charge.

Capacitors: these are components which can **harbour** electrical charge.

Inductor: stores charge and stops and change in current.



Diode: allows current to pass in one direction only, blocking the other.

Switches: can either allow current or block depending if they are closed or open.

PCB Assembly

These components can be attached to the board in various ways. In general, an engineer will choose to use either the **surface mount** method or the **through-hole** method to attach the components. Following a **schematic pattern** and using the numbers on the silkscreen, the engineer uses solder to attach the components to the board. The engineer must be very careful when soldering. As solder is a metal that an engineer **melt**s so that they can **manipulate** it. Any **stray blobs** that are out of place and touch other metal components could cause the circuit to **short**. ***3) …*** When the components are installed correctly, the PCB is ready to be used in a device.

This is only an overview, as PCBs can get extremely complex with advanced electronics. However, the basic principles remain the same, even with 16 layered boards.

5. ***Read the text again and decide if the statements are true (T) or false (F). Correct the false ones.***

1) Printed circuit boards are rather common in the world of electronics.
2) The text helps to understand how your electronics operate.
3) According to the text, any PCB is made of plastic and glass.
4) Advanced electronics needs single sided boards.
5) Letters and numbers drawn on the silkscreen make the assembly of the PCB easier for the engineer.
6) The copper traces make the skeleton of the PCB, and the components are the vital organs with different functions.

7) To attach the components an engineer will choose to use the surface mount method.

6. Combine words from A with words from B to make word partnerships. Translate them.

A	B
electronic	pad
plastic	trace
copper	layer
different	device
correct	line
additional	board
advanced	charge
original	components
electrical	destination
solder	connection
recognizable	mask
metal	design
basic	part
intended	circuits
electric	range
unique	colour
wide	qualities
various	current
schematic	purpose
stray	structure
	blobs
	pattern
	electronics
	function
	ways

7. ***Read the text and complete the chart***

<table>
<tr><td colspan="5">Components of a PCB</td></tr>
<tr><td colspan="3">external</td><td colspan="2">internal</td></tr>
<tr><td colspan="2">electrical</td><td>… (…)</td><td colspan="2" rowspan="2">Function:
…</td></tr>
<tr><td>passive
Function:
…</td><td>…
Function:
…</td><td>Function:
…</td></tr>
<tr><td>Resistors,
…, …, …</td><td>…, …, …
…</td><td>Stiffeners, …, …, …</td><td colspan="2">Core, …, … …, …
…, … …, …</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

What Are the Components of a PCB

A printed circuit board is a versatile and integral component of electronic equipment. It provides mechanical and electrical support to various external components that the assembler has mounted on it. The printed circuit board also has internal components that provide it with the special characteristics necessary for it to function as intended in the equipment. Here, Rush PCB Inc provides some understanding of the external and internal components of a PCB.

External Components on PCB

There are several types of external electronic components and non-electronic components that can go onto a PCB. However, according to their method of mounting, it is possible to divide the external electronic components into two categories—Through-Hole Components (THC) and Surface Mount Components (SMC).

Electronic Components

Whether THC or SMC, there are numerous electronic components that designers use on PCB for various electrical functionality to achieve their desired results. Depending on their functionality, it is possible to classify electronic components into passive and active types.

Passive Electronic Components

Passive electronic components usually impede the flow of electrical signals through them, but do not alter the signals in any way. Examples of such components are resistors, capacitors, inductors, connectors, and so on.

Active Electronic Components

Active electronic components alter the electrical signals that travel through them. They typically have a control that guides them to change the signal flow depending on specific conditions occurring around them. Examples of such components are diodes, transistors, integrated circuits, and so on.

Designers use a combination of active and passive electronic components to build up a schematic that functions as the designer intends. Based on the schematic, the designer prepares a layout that they transfer to the board as the printed circuit. When the assembler adds the necessary components to the board and solders them, the assembly functions as the designer intended the original schematic to function.

Both active and passive electronic components may be further classified according to their method of mounting.

Through-Hole Components (THC)

THCs usually have long leads that require mounting through holes drilled into the PCB. The design of the PCB is such that mounting of THCs is from the top, while the leads protrude through the board. Although there can be copper traces on both sides of the board, THCs occupy only the top side. At the bottom side, the leads terminate on pads, and a wave soldering process anchors them to the pads with solder.

As they have leads, THCs are often large components and therefore, do not offer high component density. Moreover, as they require drilled holes in the board, two additional processes, drilling and plating, are necessary in the manufacturing stage. The plating is necessary to produce barrels in the plated through holes or PTH that pass through the board from one side to the other.

Surface Mount Components (SMC)

SMCs offer much higher component density because these components have very small leads and they are physically much smaller.

Mounting them does not require any holes in the PCB, and hence, it is possible to pack them much closer together on the PCB. For mounting SMCs, it is necessary to place them on pads on the same side of the board.

Mounting SMCs requires placing them on a layer of solder paste. Depositing this solder paste requires an accurate stencil. As the components are very small, using a pick-and-place machine is necessary to pick them up from their reels and place them accurately in their specific positions on the board.

Soldering SMCs requires a reflow soldering machine. Reflow soldering machines have successive zones heated with Infra-red lamps to raise the temperature up to the level where the solder in the solder paste can melt. Once melted, the solder anchors the component to the board, and the temperature cools off, allowing the solder to solidify.

Mechanical Components

Apart from electronic components, there may be other plastic or metal components on a PCB that function purely as mechanical support. These may be stiffeners, screws, connectors, shields, and other related components.

Internal Components of a Printed Circuit Board

For the circuit board to allow the external electronic components mounted on it to function as the designer intended, it must have a specific internal composition. The internal design of the board must allow it to perform in a specific way. This is possible only is the board has internal components like a core, prepreg, copper foils, solder mask, surface finish, and silk screen.

Core of a Printed Circuit Board

The core of a PCB gives it the necessary mechanical stiffness necessary to carry all the external components and a physical form. In general, the core constitutes woven glass cloth cured in epoxy. This is also known as copper clad, as the core has two copper foils bonded to it on each side.

Prepreg in a Printed Circuit Board

The core or copper clad forms only a double-sided PCB. However, most boards are more complicated with many layers. PCB fabricators use prepreg to build up the stack of a multi-layered board. Like the core, prepreg are also woven glass cloth immersed in epoxy, but not cured. The fabricator uses the prepreg in between a core and a copper foil, acting as an insulation. With the application of heat and pressure, the epoxy in the prepreg cures and bonds the two copper foils together. The fabricator adds more layers of prepreg and copper foils or copper clads and bonds them as necessary to make up a multi-layered board.

Before bonding, the fabricator must transfer the circuit on to the internal copper layer, etch it and remove the unwanted copper. They must also drill via holes and plate them to provide the plated through holes.

Copper Foils in a Printed Circuit Board

Copper foils are the most important part of a PCB, as these provide the electrical connections between the external components. Depending on the number of layers, there may be several copper foils in a PCB. The core of the PCB has two copper foils bonded to it. The fabricator may have to bond additional copper foils to the core using prepreg as insulator, depending on the number of layers the PCB must have. Before bonding, the fabricator must transfer the circuit for the layer on to the copper foil, drill and etch it to remove the unwanted copper.

Solder Mask

If the copper traces on both external sides of a PCB remain exposed to the elements, they may tarnish and erode. This happens because the air may contain sulfur and other harmful chemicals. To protect the copper traces, the PCB fabricator covers them with an epoxy coating known as a solder mask.

The solder mask epoxy typically covers the entire copper trace, except for the pads where the component will be soldered. As most manufacturers use a green color for the solder mask, the entire PCB looks green. However, they may also use other colors for the solder mask other than green.

Surface Finish

It is necessary to also protect the exposed copper pads from tarnishing until the assembler can mount components on them and solder them. For this, PCB fabricators use a covering of surface finish on the pads. The surface finish can be solder, silver, tin, gold and other metal or organic substances covering the pads. The surface finish apart from protecting the exposed pads also helps in proper soldering of the external components on the board.

Silk Screen

The silk screen acts as an aid to the assemblers of external components, guiding them to their proper positioning, orientation, and polarity on the PCB. The fabricator applies the silk screen as a line drawing on the PCB. The material is an epoxy paint with a contrasting color to that of the solder mask to make it easy for assemblers to read. The silk screen also acts as a guide to mounting other mechanical components on the PCB.

Conclusion

According to Rush PCB Inc, all components of a PCB, whether internal or external, are important and necessary to allow it to function properly as the designer intended.

8. Read the text again and answer the questions:

1. What is the role of a PCB?
2. What external components are there on a PCB?
3. What categories of external components is it possible to define according to the method of mounting?
4. How can electronic components be classified depending on their functionality?
5. What is the function of passive electronic components? What are they?
6. What is the function of active electronic components? What are they?
7. What is another term for non-electronic components? What are they made of? What are they?
8. Why does a PCB need internal components? List them.

9. Get ready with the summary of the text What Are the Components of a PCB.

10. Make a presentation on the Components of a PCB.

Vocabulary

accidently	случайно
advanced	передовой, нового поколения
amplify	усиливать
assembly	сборка, установка
blob	шарик
capacitor	емкость, конденсатор
colour coded	окрашенный в разные цвета, цветокодированный
compromise	*зд.* нарушать
copper	медь, медный
copper line	кабельная линия
current	ток
flow through	пропускать через, протекать
function	назначение, функция; действовать, работать, функционировать
harbour	накапливать
house	вмещать в себя, нести
in the place of	на месте, вместо
inductor	катушка (индуктивности)
install	устанавливать, размещать, монтировать
insulate	изолировать
intended purpose	конструктивное назначение, предназначение
layer	слой
light emitting diode	светодиод, светодиодный
light up	загораться, светиться
line	*зд.* электрическая цепь, провод
manipulate	работать с
melt	плавить, расплавлять
pad	контактный столбик
path	канал, маршрут,
pattern	трафарет, шаблон, структура
PCB (printed circuit	печатная плата

board)	
provide power	подавать питание
schematic	чертеж; схемотехнический
short	замыкать
silkscreen	трафарет
single sided board	односторонняя плата
solder	припаивать; припой, пайка
solder mask	паяльная маска, припойная маска, трафарет для нанесения припоя
stray	случайный, отклоняющийся
surface mount	поверхностный монтаж
switch	выключатель
technology behind	технологическая база
through-hole	сквозное отверстие
ubiquitous	повсеместный, универсальный, широко распространенный
vital organs	жизненно важные органы
voltage	электрическое напряжение

Unit V
ESSENTIAL HARDWARE TOOLS EVERY ELECTRONIC ENGINEER NEEDS

Grammar: The Infinitive Constructions

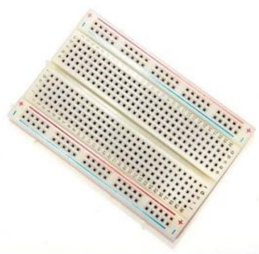
1. ***Discuss what tools you need as an electronic engineer. Match the words / word combinations and the pictures:***

1) solder; 2) **soldering iron**; 3) **soldering gun**; 4) **soldering iron stand**; 5) **solder sucker**; 6) **wire cutter**; 7) **wire stripper**; 8) **multimeter**; 9) **oscilloscope**; 10) **breadboard**; 11) **jumper wires**.







2. ***Read the text to check your ideas.***

Before you start any engineering project make sure you make a list of tools needed for your experiment. Not having the right tools can cause problems such as time wastage and a lack of budget.

There are two types of tools needed for electronic engineering experiments; these include software tools and hardware tools. The tools generally depend on the type of project you are carrying out; we've made a list of essential hardware tools to help make it easier to narrow down which tools you may need for your specific project.

Soldering

Soldering involves joining two or more metal pieces through a filler metal by melting it. Soldering is generally used by electronic engineers and requires essential tools to carry out.

Soldering Iron

A soldering iron provides heat to melt the solder in order for the joint to be filled between two work pieces. The iron has a **heated metal tip** and an **insulated handle** and is generally used for repairs, installation and assembly production work. The many types of soldering irons include; **cordless irons**, **soldering station**, simple irons and temperature controlled soldering irons.

Soldering Iron Stand

A soldering iron stand should be used to hold the iron whilst hot. The stand can easily be built using a **wire spring**, spoon and wooden piece. They are also available to purchase but check the size of your iron before as there are many different shapes and sizes available.

Solder

Solder is a **low melting alloy** and is used to join two pieces of metal. Its **melting point** will always be lower than that of the metal and is generally based on **lead**, **tin**, **brass** or silver.

Soldering Gun

A soldering gun is used to solder metals by using solder. It is usually used with a tin based solder to help achieve greater strengths and bonds. A soldering gun should be used when more heat is required than what can be achieved from a soldering iron. The guns tip gets cool quickly in order for you to use it after a few seconds. We advise that you use the temperature controlling button with care to help avoid any injuries or damages.

Solder Sucker

To remove soldering you can use a solder sucker. This can commonly be used for repair, maintenance and replacement processes and is known as **de-soldering**. To de-solder heating the joint is required followed by removing it by the sucker. The three types of soldering suckers available are, the **bulb**, the **plungers** and the **electric vacuum**.

Cutting Tools

Additionally, there are many general tools needed during electronics projects, most of which are used for cutting purposes.

Wire Cutters

Wire cutters are a cutting tool used during many electronic engineering projects and come in many different shapes and sizes.

Wire Strippers

Wire strippers are a small tool used for stripping purposes of electrical insulation. They are a hand held tool and are available in a range of prices.

Making Measurements

Multi Meter

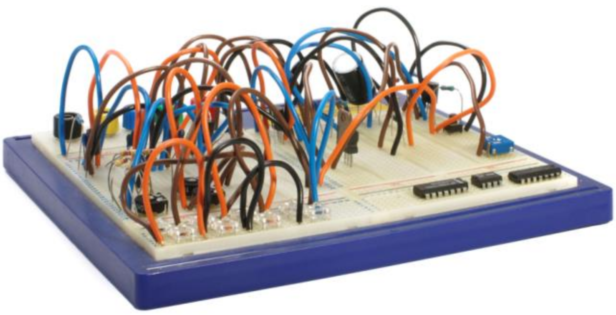
A multi-meter measures **voltage**, **current** and **resistance** and can be used as a **handheld device**. They can be used to find electrical problems in both industrial and household devices including electronic equipment, **motor controls**, **domestic appliances**, **power supplies** and **wiring systems**.

Oscilloscope

An oscilloscope measures two different things; these are voltage and time or **frequency**. They come in a variety of forms including digital, analogue and **cathode-ray** and the different models available are **Dual Beam**, Cathode Ray, Digital and hand held. Oscilloscopes are used to observe the change over time in an electronic signal, such as the voltage and time.

Prototyping tools

Breadboard



A breadboard can easily be used for university or school products as it's reusable. It is a solder less board and is usually a construction base for prototyping electronics. The breadboard is **nickel, silver or tin plated** and mostly uses jump wires. It also has a horizontal connection point.

Jumper Wires

To make connections on the breadboard, jumper wires are generally used. They can also be connected to separate boards or devices as they are generally **compatible** with 2.54mm or 2mm headers.

https://www.pcbtrain.co.uk/blog/essential-hardware-tools-every-electronic-engineer-needs

3. ***Complete the sentences with the words and word combinations from the table.***

solder, soldering, soldering guns, soldering iron, soldering iron stand, soldering station, solder sucker, wire cutter

1) … is a very intricate process used to join two materials without fusing them. Unlike welding, it does not melt the metals. Instead, it melts solder (filler material) and joins the two metals. 2) A … … is a complete kit that comes with all the essential tools for soldering. 3) … … is the most basic soldering equipment that is shaped in the form of a pen. 4) … … are

shaped like pistols and are operated using electricity. 5) … is the filler material that melts and joins the two materials. 6) … … is also known as a desoldering pump. It is used to remove solder from PCBs. 7) … … … allows you to keep the hot soldering iron away from your work area after use. 8) If you are soldering electrical wires, then you definitely need to have a … … in your arsenal. They make short work of cutting the wires and stripping the ends.

4. ***Read and translate the sentences. Pay attention to the Infinitive Constructions (Complex Object or Complex Subject).***

1. Now we know lead to be poisonous for people. 2. Lead solder and lead-free solder are considered to be two main types of soft solder. 3. Another type of solder is known to connect glass to other things. 4. They expected the guns tip to get cool quickly. 5. A breadboard is reported to be used for university or school products. 6. We would like you to make a list of tools needed for your experiment. 7. Combining integrated circuits is likely to improve performance.

5. ***It's interesting to know. What information is new (is not mentioned in the text of exercise 2)?***

Solder

Solder is a metal or alloy that melts at a low temperature. There are two types of solder: soft solder and hard solder. Soft solder melts easily with soldering irons and is used for electronics and electrical work. Hard solder melts at a higher temperature with a torch. Using solder is called soldering.

There are two main types of soft solder: lead solder and lead-free solder. Lead solders have about 60% (or 63%) tin and 40% (or 37%) lead in them. They are toxic because they have lead in them. They melt at around 185°C. Lead solder is cheap, so it used to be popular. In plumbing, a 50% tin and 50% lead mixture was used. People thought this was safe, but then they saw that the lead was coming into the water. Now lead solder is illegal for water. Lead solder was once used for food cans. After many years, the lead could come into the food. The cans poisoned people who ate the food. Lead solder is still used in electronics.

In 2006 the European Union, China, and California banned lead in consumer products. Lead solder became illegal in electronic devices in some places. Lead-free solder was needed. Many lead-free solders have tin, silver, and copper in them. They melt around 217°C. Sometimes indium is added to the solder to make it better, but indium is very expensive.

Many times when a metal is being soldered, it oxidizes, making a layer of metal oxide that does not hold solder. Flux is added to react with the metal oxide and turn it back into the metal again. That helps the solder connect to the metal. Rosin is a common flux. Some electronics makers use fluxes that can be washed away with water. Some solders have a flux core, where the flux is inside the solder.

Another type of solder is used to connect glass to other things. They melt around 450-550°C.

https://wiki.kidzsearch.com/wiki/Solder

Vocabulary

brass	латунь
breadboard	монтажная плата
bulb	капсульный
cathode-ray	электронно-лучевой; катодное излучение
compatible	совместимый
cordless iron	беспроводной паяльник
current	сила тока
cutting tools	режущие инструменты
de-soldering	выпайка
domestic appliances	бытовые приборы
dual beam	двухлучевой
electric vacuum	электровакуумный
frequency	частота
handheld device	мобильное устройство, карманное устройство

header	подложка, ножка
heated metal tip	металлический наконечник с подогревом
insulated handle	изолированная ручка
jumper wires / jump wires	навесные монтажные провода
lead	свинец
low melting alloy	легкоплавкий сплав
melting point	точка / температура плавления
motor control	блок управления двигателем
multi meter	тестер, вольтамперметр, универсальный измерительный прибор
nickel plated	никелированный
oscilloscope	осциллограф
plated	покрытый металлом
plunger	поршневой
power supplies	источники питания
prototyping tool	инструмент прототипирования
resistance	сопротивление
silver plated	посеребренный
solder	припой
solder sucker	пневмоотсос припоя
soldering	низкотемпературная пайка
soldering gun	паяльник, пистолетный паяльник
soldering iron	паяльник
soldering iron stand	подставка для фиксации
soldering station	паяльная станция
tin	олово
tin plated	покрытые оловом
voltage	напряжение
wire cutter	кусачки, клещи-кусачки
wire spring	проволочная пружина
wire stripper	устройство для удаления изоляции с проводов
wiring system	система соединений

Unit VI
THE BASICS OF DESIGNING PCBS WITH CAD
Grammar: The Participle

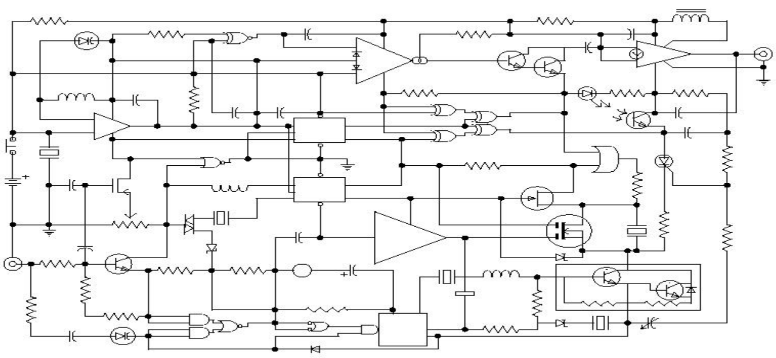
1. ***What is design? What can people design? Discuss these questions with your groupmates.***

2. ***Read the text to find out what CAD is and what is its role in creating a PCB.***

What is CAD?

CAD, or **Computer Aided Design** is the process of using computer software to draw, design and develop a product or concept. CAD programs allow a person to create a **visual representation** of an object. It is extremely useful to a number of industries. This includes **naval and aero engineering**, architectural and **product design** industries now use CAD **prolifically**. This is also the case in printed circuit board design and production.

PCBs and CAD



CAD is used during the development process of creating a PCB. There are many different types of CAD software to choose from. Take a look at free software, such as Design Spark, KICAD and FreePCB. Though they basically do the same thing, every CAD program works slightly differently, so a designer will choose the one that suits them best.

Schematic capture

This design process begins with the CAD **technician mapping** the component positioning and connections that will be on the PCB. This is known as ‘schematic capture’ in PCB talk. The CAD schematic acts as a sort of **blue print** for the circuit that is being designed. It determines what components will be in the PCB and how they are joined. The **electrical trace**s on a **schematic** are called ‘nets’. A designer can use an existing schematic design, or create their own. A designer will **run simulations** to test how well the schematic will operate as an actual circuit. This is one of the major benefits of CAD; when circuit designs were hand-drawn such **faults** would not be noticed until the circuit had actually been made.

Turning a schematic capture into a circuit

Once a schematic has been tested and approved the design must be transferred into an actual CAD drawing of the circuit board. The **dimensions** of the board are realised, along with the **placement** of the components and the copper trace connections. Often, programs will have a ‘**switch to** board’ (or similar) command on the CAD program. This allows you to place components onto your on screen board. The CAD designer places the components and labels them with their name and value. When designing the schematic the **grid** is not important, but it becomes crucial when editing the actual board. The movement tool is selected to move parts about (called different things in different CAD programs) and they can be rotated to fit onto your board. A designer will try not to overcrowd components or cross your copper traces, as this would cause the circuit to short.

The CAD circuit will become more complicated as you add multiple circuit board layers. A designer will usually route one layer horizontally and the next one vertically. **Allowances** should also be made for the **physicality** of components. Taller ones will have to be placed in certain areas, depending on the final destination of the circuit board. The components must have the complete information that they would require to be a part of the board. This includes any drilling information, the footprint for the board pads etc.

Routing

This is the stage in which the designer routes the copper connections between the components. The CAD software will route the connections in accordance with information from the schematic capture. Often, the CAD software will have a ‘route’ tool to assist with manual routing. However there are also programs that have auto routing software. As mentioned earlier, the crossing of traces must be avoided when routing. If traces need to be crossed, the designer will make it so they cross on opposing sides of the board. Traces can be transferred from one side of the board to another using ‘vias’: these are small drill-holes that are loaded with copper on an actual circuit. Once all the copper traces have been routed the CAD program will often have an option that checks for errors in the PCB design. Once all the errors are corrected the PCB design is complete and ready to be made into a real circuit.

https://www.pcbtrain.co.uk/blog/the-basics-of-designing-pcbs-with-cad

3. ***Read the text to get further information on electronic design with the CAD. Why has CAD become pivotal to the ongoing process of manufacturing complex electronics?***

The Role of CAD in Electronic Design and Manufacture

Computer Aided Design (CAD) refers to any software that aids developers in the creation of their product. ECAD (Electronic Computer Aided Design) and EDA (Electronic Design Automation) refer specifically to CAD software designed for electronic design. In the electrical engineering field, CAD has become **pivotal** to the ongoing process of manufacturing complex electronics like printed circuit boards (PCBs) and microprocessors that are designed **down to** the subatomic level. The software provides a large number of tools and functionality that allow electronics companies to make the products that drive the age of information technology. The main benefit is that designs are converted directly to a production machines format, removing the possibility of human error. This improves quality and keeps costs down. This is especially true on larger scale designs or projects.

The Role of ECAD

Until an electronic device goes to the production line, ECAD is the most important tool of the design process. It performs the primary tasks of constructing electrical schematics, performing simulations, and creating physical blueprints for electronic devices ranging from the latest microprocessor to powerful graphic processing units. It is the primary reason that electronics have advanced from processors with just over 2000 transistors to ones with billions packed onto them.

ECAD Functionality

The available functionality of ECAD software can be summed up as the design and testing of complex electronics schematics on both the physical and logical level. The schematics generated for both aspects are stored in digital format with frequent backups, making it easier to modify and distribute.

On the electrical side, ECAD programs typically come with the ability to design the electronics schematics from the ground up and eventually run simulations to determine how the hardware will respond when an electronic input is given. This is done by using the software language to replicate the logical functions that electronics goes through. For a simple example, if an AND logic gate is shown on the schematic, the simulation would take all the inputs into the gate and perform the same process at the application level. The program would do this for all possible inputs in order to quickly and automatically test the schematic. Many of the programs also offer the ability to create “cells” that act similarly to logic gates or solid-state chips.

Every electrical component has a physical manifestation, and complete ECAD software manages this aspect as thoroughly as it cares for the logic process. The software allows the engineers to place the physical components represented in the electrical diagram onto a model of its physical form. Any discrepancies, such as overlapping parts or a lack of room, are noted and can then be corrected well before the manufacturing process.

ECAD Programs

There are a number of both open source and commercial options available for EDA software. On the commercial side, the top options include programs such as: Zuken’s CADSTAR, Mentor Graphics’ collection of programs, and Synopsis Design Compiler. The most popular open source tool is gEDA, developed for Linux due to the low availability of quality open source EDA tools.

The Future of ECAD

With the ongoing trends towards solid-state devices and placing more complicated systems on a single electronic component, the demand for powerful ECAD software will continue to rise. More open source options are appearing, meaning that both electronic design companies and scientists will have the tools they need to design electronics to control the giant robots and flying cars of the future.

https://www.pcbtrain.co.uk/blog/the-role-of-cad-in-electronic-design-and-manufacture

4. ***Prepare a short summary on the role of CAD in electronic design and manufacture processes.***

5. ***Read the texts again to draw a diagram showing the stages of electronic design process with the CAD.***

6. ***Use the diagram to describe the stages of electronic design process with the CAD.***

7. ***The Participle. (See Appendix 2, Grammar Reference 4).Translate the sentences into Russian. Pay attention to the forms and functions of participle.***

1. Cavitation occurs, resulting in shock waves that disrupt tissue through a mechanical mechanism. 2. The lasing medium is activated by an energy source. 3. The specific molecules in the lasing medium are excited to their characteristic higher energy levels and, reaching a threshold, they produce a series of laser light emissions at specific wavelengths. 4. The energy output at each wavelength is determined by the number of molecules at the corresponding energy level. 5. The wavelength emitted is theoretically possible throughout the entire electromagnetic spectrum, ranging from X-rays through to microwaves. 6. The high concentration of coherent light energy produced provides lasers with many of their capabilities.

7. Luminescence can be described as the emission of light energy from a molecule at specific longer wavelength(s), than the wavelength absorbed. 8. The luminescence wavelength profile is usually a characteristic of the particular substance irradiated. 9. The effect on tissue depends on the method by which the energy is delivered, the amount delivered, the duration of the exposure, and the wavelength used. 10. It is the mechanism employed for the ablation and recanalization of non-calcified atherosclerotic plaque. 11. Plasma is a high-energy state resulting from a high-intensity, short-pulse duration of laser light.

8. ***The Participle. (See Appendix 2, Grammar Reference 4).Choose the proper form of the participle in brackets.***

1. A computer is used to display the measurements as an image (representing/being represented) a cross-sectional radiograph of the patient. 2. A computer is used to display measurements (representing/ represented) by an image of a cross-sectional radiograph of the patient. 3. (Used/Using) appropriately, CT is capable of making a major impact on management decisions. 4. (Used/Using) CT we can make decisions. 5. (Having examined/examining) patient's body doctors took him to the operating theatre. 6. (Having examined/examining) his new discovery he learnt all the possible harmful effects. 7. (Being examined/examining) the patient answered a lot of questions. 8. The basic image (manipulating/being manipulated) can be reprocessed to give a high resolution image. 9. Nowadays (used/using) specially constructed computer hardware doctors can plan radiotherapy on the basis of CT images.

Vocabulary

aero engineering	авиационная техника
allowances	нормативы, допущения
blue print	проект, предварительный план
Computer Aided Design (CAD)	Система автоматизированного проектирования (САПР)
dimensions	размеры
down to	вплоть до
electrical trace	электрическое соединение
fault	сбой
grid	координатная сетка чертежа
map	составлять схему
naval engineering	военно-морская техника
physicality	состояние, физическое качество
pivotal	важнейший, основной
placement	размещение
positioning	размещение
product design	проектирование изделия
prolifically	в изобилии, в большом количестве
routing	трассировка, маршрутизация
run simulations	проводить моделирование
schematic	принципиальная схема
schematic capture	ввод описания электрической схемы
switch to	переключиться на; переход на
technician	специалист
visual representation	представление в графическом режиме

Unit VII
FUTURE CAREER
Grammar: The Gerund

1. ***Discuss with your groupmates advantages and disadvantages of your future career. Try to prove your opinion.***

1. Do you think that profession of an engineer is prestigious nowadays?
2. Is this profession much wanted?
3. Is it difficult to find a good job in the field of electronic engineering?
4. Is there a shortage of good quality graduate engineers in our town?
5. Are engineers well paid?
6. Is this career more suitable for men or women?
7. Does this profession require much time or efforts for education?
8. Does it require any special traits of character?
9. Does the career of engineer in the field of electronic engineering require permanent self-education?

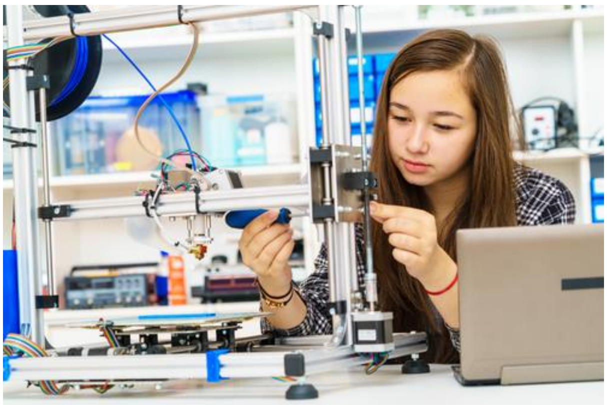
Notes: *career* – *зд.* род деятельности, профессия
job – работа, место работы
work – работа, занятие

2. ***Read the text to find out advantages of working in electronics.***

9 Reasons You Should Work In Electronics

Electronic engineering is a field where the sky is the limit, this is especially true recently with the **shortage** of engineers in the UK.

1. Opportunities worldwide



Electronics are essential in many careers worldwide, a career in electrical engineering can allow you to **experience** the world and get a good **wage** for doing so. Many companies even offer benefits or free time to take in the sights whilst working for them.

This way you can **further** your career, gain knowledge and enjoy a completely new setting.

2. High average starting wage

Finances can be **strained** post university as you enter possibly the hardest time financially of your life – before you've had time to progress in your career you need to be saving your money not spending it. Electronic and electrical engineering positions have high starting **salaries** after graduation compared to other fields. This can make this tricky period less stressful.

3. DIY

Doing tasks yourself is not only **immensely rewarding**, it saves money and makes you look pretty cool. Most people can change a light bulb, but you'll be able to fix and diagnose issues in far more complex devices. You can even create your own solutions to household problems if you feel so **inclined**.

4. A start you won't regret

While the studying might be more difficult than a lot of other options, it **sets** you **up with immense <u>problem solving skills and abilities</u>**. You may not even **end up in** the electrical engineering field – but you most likely won't regret your initial decision to study it.

5. New technology and methodology

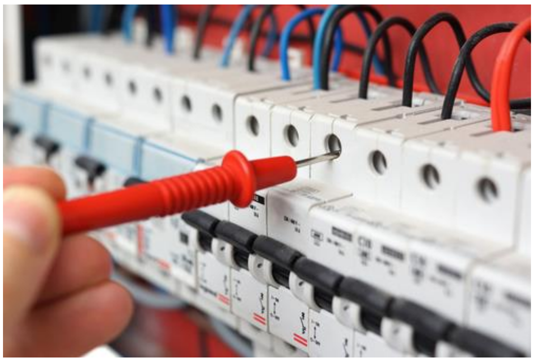
As technology and methodology is ever changing, there's a high chance the way you work and how you work will change over time too. This definitely makes things a lot more interesting and gives your daily work-life much more variety.

6. Problem solving

Problem solving is key to many different jobs related to electrical engineering. This can feel very rewarding and makes the field uniquely **satisfying** to you when working within it. Constant problem solving has been linked to high levels of job satisfaction and is one a **sought after** skill from employers.

7. Helping others

Engineering in general is based around improving various systems. This in turn **boosts** the quality of life worldwide. It can be very satisfying to see products in real life having a big effect on people that you **had a part in** developing or improving.



8. Changing the world

Whichever area you're working in, you have the capacity to play a part in changing the world. Developing new technologies in areas like healthcare are incredibly **impactful** on the daily lives of many, and this is true of every electrical engineering field.

9. Job security

The sector you'll be working in is essential to the functioning of economies and societies worldwide. Plenty of roles are available and will continue to be, especially in the UK where businesses claim a shortage of engineers.

https://www.pcbtrain.co.uk/blog/9-reasons-you-should-work-in-electronics

3. ***You have decided to choose a career of electronic engineer. Now you know the advantages. Read the text to find out how to become an electronic engineer in the USA. Is it the same in Russia? What are the similarities and differences?***

How to Become an Electronic Engineer

Learn how to become an electronic engineer. Research the education and career requirements, **licensure** and experience required for starting a career as an electronic engineer.

Should I Become an Electronic Engineer?

Electronic engineers focus on the manufacturing of various types of electronic equipment, including communications and navigation systems, motors, and power generation equipment. To manufacture these pieces of equipment and devices, electronic engineers create designs and build prototypes. Most work is accomplished in offices, although **site visits** are sometimes required.

Prospective electronic engineers must **earn** at least **a bachelor's degree** in electronic engineering. While not required, passing the **Fundamentals of Engineering (FE)** and **Principles and Practice of Engineering (PE)** exams to obtain licensing may be preferred by employers.

Step 1: Earn a Bachelor's Degree

Let's look at the steps necessary to become an electronic engineer.

Most job openings for electronic engineers require applicants to hold a **bachelor's degree** from a program accredited by **ABET**. These 4-year engineering programs are often housed in computer or electrical engineering departments. They have significant mathematical requirements that can include a sequence in calculus plus a differential equations course. Students may also be required to complete a physics sequence.

Electronic engineering curricula for undergraduates often include coursework in circuitry, communications systems, and computer programming. Some courses include technical labs in addition to lectures. The **capstone** of many electronic engineering programs is the **senior design project**, in which students research and design an original concept. Many students also choose to **pursue cooperative internships** in the summer to gain practical work experience.

Potential electronic engineers may also want to pass the Fundamentals of Engineering (FE) exam. The first section of the FE covers math, science, and basic engineering topics, including materials and mechanics. The second section tests individuals on their specific discipline. Engineers who pass the exam earn the **Engineer in Training** or **Engineer Intern** designation.

Step 2: Gain Work Experience

According to the U.S. Bureau of Labor Statistics (BLS) in 2020, the industries that employed the most electronic engineers were the engineering services, and the electric power generation, transmission and distribution sectors. Additional industries that offered high levels of employment included navigational, measuring, electromedical, and control instruments manufacturing, and research and development in the physical, engineering, and life sciences. The BLS reports that job growth is estimated to increase by 7% from 2020-2030. The highest area of employment for many electronic engineers is projected to be within telecommunication firms.

Step 3: Pass the PE Exam

After four years of work experience, electronic engineers can **sit for** the **Principles and Practice of Engineering (PE)** exam. Electronic engineers can select the electrical and electronics version of the PE, which covers topics that include electronics, digital systems, and communications. Passing the PE is typically the last step that individuals must take to become licensed engineers. Passing this exam can create better career opportunities and advancement for engineers.

Electronic engineers need at least a bachelor's degree in the field. Taking and passing the **Fundamentals of Engineering (FE)** and **Principles and Practice of Engineering (PE)** exams can help open better career opportunities.

https://bestaccreditedcolleges.org/articles/electronic-engineer-how-to-become-an-engineer-in-the-field-of-electronics.html

4. Read the text again and answer the questions.

1. Is there the shortage of engineers in the UK? In Russia?
2. What can you experience working in electronics?
3. Do electronic engineers have high salaries after graduation?
4. What does DIY stand for?
5. Is studying engineering difficult? What does it provide you with?
6. What makes things and your daily work-life a lot more interesting?
7. What skill is one a sought after from employers?

8. Can engineering boost the quality of life worldwide? If yes, in what way?

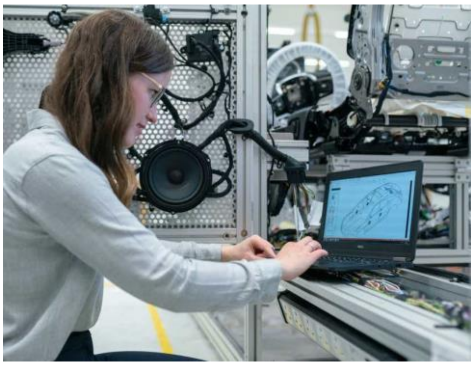
5. ***Read the job description to find out the requirements one should meet as an electronic engineer, main responsibilities and skills. What should you do to meet all the requirements mentioned in the text? Is it enough to complete your course at the university?***

Electronics Engineer Job Description

Learn about the key requirements, duties, responsibilities, and skills that should be in an electronics engineer job description.

Electronics engineers use their knowledge to design, develop, evaluate, and maintain electronic systems and components. They may be employed by small companies or work in commercial sectors. Day-to-day duties vary based on the field, but they generally design, plan, perform research, inspect the equipment, attend conferences, and **liaise** with others.

Electronics Engineer Job Description Template



We are searching for a passionate, reliable electronics engineer to join our growing company. The electronics engineer's responsibilities include interpreting **client briefs** and providing **cost and time estimates**, testing systems and writing up improvement plans, developing electronic products, components, and systems to satisfy client needs, as well as creating instructional manuals. You should be able to establish **supplier** and **vendor** networks and represent the firm at conferences.

To be successful as an electronics engineer, you should have an **aptitude for** Mathematics and a **passion for** technology. Outstanding electronics engineers are able to **prioritize** tasks, solve problems, and **deliver work to strict deadlines**.

Electronics Engineer Responsibilities:

- Designing, inspecting, testing, and updating electronic systems, components, equipment, and software.

- Liaising with engineers, other professionals, as well as clients to ensure quality projects are completed to specifications.
- Ensuring all equipment and products meet health and safety regulations.
- Observing existing processes and making recommendations for improvement.
- Developing effective maintenance, testing, and quality control procedures.
- Showing initiative and keeping up with advancements in Electronics.
- Representing the company at conferences and delivering presentations if required.
- Monitoring processes, systems, and staff, and punctually identifying problems.
- Establishing relationships with staff, vendors, suppliers, and other professionals in the field.
- Writing specifications, instructions, reports, and handling other required administrative duties.

Electronics Engineer Requirements:

- Bachelor's degree in engineering or similar.
- Master's degree preferable.
- A relevant license may be required.
- Practical experience with design software.
- Experience in design recommended.
- Excellent problem-solving and **troubleshooting** skills.
- Strong written, verbal, and telephonic communication skills.
- Excellent research and interpersonal skills.
- Strong analytical skills.
- Willingness to work overtime if required.

6. ***Every year our University holds Open Days in order that prospective students can find out more about the range of study opportunities at the University. Being current students you can***

answer the following questions to provide a realistic picture of studying at your department.

1. When was the Department of Electronics, Instrument Making and Bioengineering Systems established? 2. Why is this department important? 3. What general educational subjects do students of this Department study? 4. What special subjects are provided at the Department? 5. Who teaches students? 6. What types of learning activity is there at the University? 7. What kinds of the assessment are there? 8. What do the undergraduates do during their final year? 9. Where can graduates work after getting their diploma?

7. ***Get ready to speak on the topic "My future career" using the information and vocabulary of the lesson.***

8. ***Translate the sentences into Russian. Pay attention to the forms and functions of the Gerund.***

1. The elevated thermal effects, including tissue charring, unwanted coagulation, spasm, perforation, thrombosis, and subsequent development of aneurysms, limited the application of these systems. 2. The development of the hot tip was the first attempt at controlling the energy delivery of continuous-wave radiation by encasing the tip of the fibres with a metal jacket that was heated by the latter. 3. It is important to understand some fundamentals of laser energy delivery before summarizing clinical experiences. 4. Major differences between them preclude their being compared to each other. 5. If we look back into history to trace the beginning of the Atomic Age, we may start the story with an experiment performed late in the year 1895. 6. This is useful for demonstrating small structures. 7. Such images are helpful in communicating the orientation of lesions. 8. Enhancement refers to the commonly used technique of scanning following the intravenous administration of iodine-containing contrast medium. 9. It is commonly used to aid diagnosis by increasing the contrast between normal and abnormal tissues. 10. Movement artefact is a problem in studying the abdomen. 11. Although the capital and running costs of CT are high, the technique is undoubtedly cost effective.

Vocabulary

ABET = American Board for Engineering and Technology	Аккредитационный инженерно-технологический совет США
aptitude for	склонность к
boost	повышать (существенно)
capstone	ключевой, основной
client briefs	техзадание заказчика
cooperative internships	совместная производственная/дипломная практика/стажировка
cost and time estimates	предварительная смета расходов и расчет времени (на выполнение заказа)
deliver work to strict deadlines	сдавать работу в жесткие сроки
designation	категория, официальный статус
earn a bachelor's degree	получить степень бакалавра
end up in	попасть, очутиться
Engineer in Training	инженер-практик
Engineer Intern	инженер-стажер
experience	опыт; открыть для себя, приобрести опыт
Fundamentals of Engineering	Инженерные основы
further	способствовать, продолжить
have a part in	быть вовлеченным в, играть роль в
immense	замечательный, грандиозный
immensely	очень, чрезвычайно
impactful	эффективный, действенный, показательный
inclined	склонный к, настроенный
liaise with	поддерживать связь с
licensure	лицензирование, выдача разрешений
passion for	тяга к
Principles and Practice of	Теория и практика инженерного дела

Engineering	
prioritize	определять приоритеты
problem solving skills and abilities	способности к решению проблемы
pursue	стремиться, выполнять
rewarding	приносящий удовлетворение
salary	заработная плата, оклад
satisfying	доставляющий удовлетворение
set up with	развивать, вырабатывать
shortage	нехватка, дефицит
sit for (the exam)	сдавать экзамен
site visit	выезд на объект
sought after	пользующийся большим спросом, востребованный
strained	ограниченный
supplier	поставщик
troubleshooting	поиск и устранение неисправностей
vendor	продавец
wage	заработная плата

Appendix 1

SUPPLEMENTARY READING

Text 1
An introduction to Microelectronics

Electronics is a general term for the field of science that involves managing electric currents through circuits. Microelectronics is one of the sub-categories of electronics. Microelectronics specifically relates to manufacture of very small electronic circuits. It also incorporates the study and engineering of the circuits. Fundamentally, the term ‘micro’ relates to the measurement scale of a micrometer (1 x 10^{-6} meters). Microelectronics relates to electronic components at this scale or smaller.

When standard electronic components are assembled, the options include capacitors, inductors, resistors, diodes, and transistors. The same range of components is available in a microelectronic product. Wiring of microelectronic components can be challenging due to the sizes involved. Techniques have been developed such as wire bonding to help ensure effective circuits are developed, incorporating the components, leads and pads.

The cost of manufacture of microelectronics can be higher than that of standard electronics due to the need for specialized equipment. This is largely as a result of the set-up costs, but once the set-up has been addressed, the ongoing cost of manufacture can be cost effective.

Microelectronics has become a crucial factor in many aspects of our modern society (and economy). Microelectronics has been described as ‘the enabler’ of modern information technology. Microelectronic components are used in a broad range of industries including computers and software, telecommunications and media, commerce, logistics and transportation, natural science and medicine, power generation and distribution, finance, and administration.

As an example of the increase in use of microelectronics, the value of microelectronics in a modern car will be at least 15% of the value of the vehicle. In some well-equipped vehicles, the value of microelectronic components may be 30% of the value of the vehicle. The range of systems in a car that need microelectronic circuits include the electronic ignition, ABS brakes, ESC stability systems, air bag triggers, anti theft systems, travel computers, integrated instrument panels, automatic climate control systems… the list is endless. When a modern car is serviced, the technician will connect the car's computer system to identify the mechanical performance and address any issues.

Over time, the scale of microelectronics has steadily decreased. According to Moore's Law, the number of transistors in a dense integrated circuit has doubled approximately every two years. The law was first identified in 1965, and had continued to be valid for the last 50 years. A modern microprocessor chip is about 3 cm^2, and holds 100 million transistors. The same device using traditional 3mm^3 transistors would require a volume of a cube measuring 1.4m; and that actually wouldn't account for the space required for the wiring.

With the decrease in scale, 'parasitic effects' have become a challenge for engineers. Parasitic capacitance is defined as 'an unavoidable and usually unwanted capacitance that exists between the parts of an electronic component or circuit simple due to their proximity to each other'. Engineers working in the field of microelectronics must constantly seek new ways of compensating for (or minimizing) parasitic effects.

In summary, microelectronics as a field has become a crucial aspect of our society and our daily lives, from an obvious level such as a cell phone to a complex range of integrated operations in a car.

https://rushpcb.com/microelectronics-an-introduction/

Text 2
Early Microelectronics

At one time electronics were relegated to just a few areas, such as radio and television. A big reason for this was because electronics themselves were big. If you've ever seen pictures of early TV sets and radios from the 1940s and 1950s they were large, cabinet-size devices that looked more like furniture than like cutting-edge electronics. And computers? The predecessors of the latest 12 inch, five pound laptops were machines like ENIAC, the world's first general purpose electronic computer, which was developed in the 1940s. ENIAC was so large it filled entire rooms. Although ENIAC was a marvel for its time, its computing power is dwarfed by a simple modern pocket calculator. So, how did electronics infiltrate just about every appliance we use? They got smaller, and smaller, and smaller. Engineers have spent a good part of the last 50 years shrinking electronic components. This is the field of "microelectronics," the guts of modern electronics.

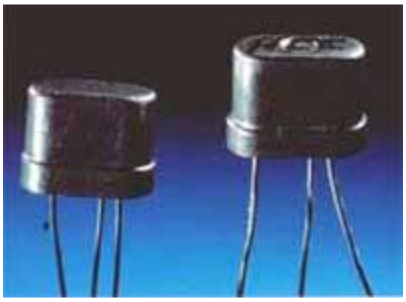
In the early days of electronics, that is before the 1950s, the basic electronic device was the electron tube (which is also commonly known as a vacuum tube), which had begun life years earlier as a modified light bulb, and stayed about that size. Electron tubes made early electronics such as radio possible, but they had some serious limitations. Their filaments burned out just like a light bulb, and to make something work you needed lots of them. ENIAC, for example, needed 18,000 tubes to function. But electron tubes were also incredibly useful. In a radio or phonograph, they could take an extremely weak signal and amplify it loudly enough so that it could fill a room. The electron tube could also be used like a switch, but unlike a regular switch it had no moving parts and so it could switch on and off incredibly fast. Computer engineers, who used electrical switches to construct elaborate "logic" circuits, chose to use the electron tube despite its size and tendency to fail.

During World War II, things began to change. Engineers undertook a bold experiment to try to pack an entire radar set into an artillery shell. They called their new device a "proximity fuse," because it could destroy by being near a target rather than requiring a direct hit. Even though they were a success, proximity fuses still relied on electron tubes, albeit, quite tiny ones. After the war, as missiles and rockets emerged, there was an increasing need for compact, rugged electronic systems for communication and navigation. The search was on for smaller and smaller electron tubes.

A replica of the point-contact transistor created by John Bardeen and Walter Brattain, under the supervision of William Shockley in 1947. Courtesy: Lucent.

While some engineers worked on building better and smaller electron tubes, others were looking for ways to do away with tubes altogether and turned to semiconductors, a class of materials valued because they could be used as diodes (a diode is a one-way valve for electricity). One was Russell Ohl of Bell Telephone Laboratories. Ohl and his fellow researchers discovered that putting two slightly different types of a semiconductor called germanium together produced a device that acted like a electron tube diode.

Ohl's work was important, but an even bigger discovery was made in



1947 when John Bardeen and Walter Brattain stumbled on the "transistor," a slice of germanium with a few carefully placed wires touching it, that was not only a valve but also an amplifier. This was the point-contact transistor. As an added bonus, the transistor produced a fraction of the waste heat and was tiny compared to an amplifier tube—the whole device could fit on the end of a finger. Not long afterwards William Shockley, also of Bell Labs, made the fragile transistor into a rugged and practical device when he invented the "junction" transistor, a sandwich made up of layers of germanium. Bell Labs announced the point-contact transistor in 1948 and the junction transistor in 1951. The germanium transistor was a milestone, but it was unreliable and engineers sought out new materials with which to construct transistors.

They found an answer in silicon, another semiconductor that had been used in diodes. Silicon proved to be a better material for making transistors. It was this type of transistor, introduced by Texas Instruments in 1954, that revolutionized the technological world. Missiles became more accurate with onboard transistor guidance systems and computers became small enough to fit on board an aircraft. Perhaps the most famous transistorized product from this era was the pocketsize radio. By the end of the 1950s, the little transistor had replaced the hot, unreliable electron tube in nearly every existing type of electronic system. It also made electronic devices smaller, cooler (in temperature, that is), and less expensive.

https://ethw.org/Early_Microelectronics

Text 3
Interesting Facts

Here are some interesting facts, incidents, memorable events and little-known facts from the lives of scientists…

Black-market radio

During World War II, the radios used by the forces were heavy and erratic, and not designed for jungle warfare. Kilby wanted to improve the situation and travelled to Kolkata, India, for a truckload of black-market radio parts. Soon, he succeeded in building smaller, more reliable radios for the troops. His invention of integrated circuit stems from this attitude, “If something does not meet your requirements, rebuild.”

First actual bug

While she was working on a Mark II Computer at a US Navy research lab in Dahlgren, Virginia, in 1947, a computer problem baffled Grace Murray Hopper and her team. When they opened the machine, they found a moth inside, stuck in a relay. Removing the offending creature, she remarked that they were ‘debugging’ the system. Hopper pasted the creature into her log book and noted, “First actual case of a bug being found!”

The remains of the moth can be found in the group’s log book at the Smithsonian Institution’s National Museum of American History in Washington, DC, USA.

She is credited with the terms ‘bug’ and ‘debug’ for computer errors and how to fix them. Hopper led the team that invented COBOL (common business-oriented language), the first user-friendly business computer software program.

Flight path of bees

When Alan Turing was around the age of seven, the family went on a picnic in Ullapool, Scotland. Thrilled at the honeybees all around, Alan got a brilliant idea of getting honey for their afternoon tea. He intently watched a few bees, plotted their flight paths and calculated the position of the hive. Soon he reached the spot and presented a treat for the family.

Turing is said to have learnt reading only in three weeks, at a very early age.

Alan Turing is regarded as the father of modern computer science and the father of artificial intelligence.

Saintly scientist

In May 1901, a scientist was adding finishing touches for his lecture at the Royal Society, London. A telegram from an industrialist seeking an immediate meeting disturbed him as he had no time to meet anyone, even a multimillionaire. He declined the invitation and received a counter reply from the industrialist informing the scientist that he was coming down to London himself.

As the scientist was about to leave for the lecture, there came Major Stephen Flood Page, the managing director of the Marconi’s Wireless and Telegraph Company, carrying a handful of papers.

The scientist later recalled his conversation with Page, “He made an earnest request not to divulge all valuable research results in today’s lecture.” “There is money in it—let me take out [a] patent for you. You do not know what money you are throwing away,” said Page. Of course, “I will only take half share in the profit—I will finance it,” he said. This multimillionaire was pleading like a beggar.

The scientist refused the offer and delivered his lecture at the Royal Society.

This gentleman was Jagdish Chandra Bose!

Pinging

'Ping' was written by Mike Muuss in December 1983.

From his home page, "I'm the architect of BRL-CAD, a substantial third-generation CSG solid modeling system, available free of charge, which you probably have never heard of, and the author of ping, ttcp and assorted other network goodies. Ping is a little thousand-line hack that I wrote, which practically everyone seems to know about. It's included in every copy of UNIX and Windows, putting it into nearly every computer on the planet. "

Sadly, Mike was killed in an automobile accident on November 20, 2000. His home page is still available, a testament to his intellect and indomitable spirit.

https://www.electronicsforu.com/special/cool-stuff-misc/interesting-facts

Text 4

All You Wanted to Know About PCB Materials

Rush PCB Inc always begin their design of printed circuit boards (PCBs) with appropriate material selection. The goal is always to use the right material for making the PCBs, while meeting the electrical and temperature requirements. With most electronic designs moving towards high-speed, a proper choice of material affects the quality of the signals traversing the board. Therefore, the choice of materials for the board defines the performance and quality of the end product.

The Constituent Materials of a PCB

To make a circuit board, manufacturers need the following three items:

Prepreg

This is a reinforcement sheet of woven glass, impregnated with a resin. Typically, this is a B stage material, not fully cured. The tacky material allows bonding of other laminates or foils. Prepreg manufacturers offer them in a variety of epoxy combinations and glass weaves.

Copper Foil

Copper foil present on the outermost layers of the PCB forms the conductive medium for electric signals and current to flow between components. Fabricators make copper traces on a PCB by etching the copper foil, thereby creating electrical connections on the board.

Copper Clad Laminates

Board manufacturers make cores that constitute prepreg laminated and cured with copper foils on both sides. Manufacturers offer a large variety of cores with different thicknesses, types of glass weaves, and epoxy properties. PCB designers define their requirement of combinations best suited for their application.

For making a copper clad laminate, manufacturers use suitable glass cloth of interwoven glass fiber and impregnate this in epoxy resin. They semi-cure this impregnated cloth and bond multiple layers to make up the desired thickness, adding copper foil on the outsides. This forms the copper clad laminate.

Important Properties of PCB Materials

While choosing material for board construction, designers must consider four basic properties of PCB materials.

Chemical Properties

Chemical properties of the PCB material are important as they decide the quality and reliability of the product. Two of the most important chemical properties are:

Moisture Absorption — This is the ability of the material to resist water absorption from the surroundings. Absorption of moisture results in the PCB gaining weight and losing some electrical properties.

Conductive Anodic Filament Resistance — This is the ability of the PCB material to resist forming metallic filaments from electromechanical migrations. These filaments are conductive and may cause electrical shorts on the PCB. Designers must use CAF resistant materials.

Mechanical Properties

Mechanical properties of PCB material determine its ability to withstand external loads and stresses while retaining its characteristics. Three important mechanical properties are:

Elastic Modulus — A measure of the stiffness of the material, defining the amount of force necessary to deform the material.

Bend Strength — A measure of the ability of the material to withstand mechanical stress without fracturing.

Tensile Strength — A measure of the maximum stress the material can withstand without breaking when pulled apart from two sides.

Thermal Properties

Thermal properties of a PCB material determine its ability to withstand extreme temperatures while retaining its characteristics. Four important thermal properties are:

Thermal Conductivity — A measure of the ability of a material to conduct heat. Compared to thermal conductivity of the copper foil, that of the dielectric material is quite low. Therefore, the copper foil removes more heat than the dielectric material of the PCB can.

Coefficient of Thermal Expansion — Rate of expansion or contraction of a PCB material as it heats up or cools down. The PCB material can expand or contract in three dimensions. Typically, the ability of the material to expand or contract along the X and Y directions are quite low. This is because the woven glass constrains the expansion in the X and Y directions. However, the ability of the material to expand or contract in the Z direction is an important parameter.

The CTE of the substrate in the Z direction is generally higher than that of copper, and this can result in interconnection issues as the material heats up or cools down. Therefore, a low CTE along the Z direction is a desirable characteristic of the PCB material.

Decomposition Temperature — This is the temperature at which the PCB material starts losing its mass or it starts chemically decomposing irreversibly. As most PCB materials undergo assembly at temperatures between 200 and 260 °C, where solder melts, the decomposition temperature of the PCB material must be higher than this range.

Glass Transition Temperature — This is the temperature range in which the PCB substrate starts to transition from the rigid, glassy state to a rubbery, deformable, softer state. The change is reversible as the board material cools down.

Electrical Properties

The electrical properties of a PCB material determine its ability to maintain signal integrity around the frequency of operation. Two parameters are of importance here:

Dielectric Constant — The relative permittivity of the material. For most materials, the dielectric constant varies with frequency, decreasing with the increase in frequency. For proper signal integrity at high frequency operation, suitable materials must have a low dielectric constant that does not vary with change in frequency over a wide range.

Dissipation Factor — With increasing frequency, power is lost in a dielectric material. This leads to signal attenuation. PCB materials suitable for high frequency operation must have a low and flat dissipation factor with frequency.

Mechanism of Signal Loss in PCB Materials

At high frequencies of operation, PCB material characteristics can affect the signal integrity. Engineers overcome this by selecting the right type of substrates and copper foil. Signal loss in PCBs is mostly due to losses in the dielectric and in the copper foil. Therefore, these two materials play a major role in causing signal loss in PCBs.

Dielectric Loss

Dielectric materials constitute polarized molecules. Time varying signals passing through the copper traces generate electric fields that cause the molecules to vibrate. The dielectric heats up due to these vibrations, resulting in the dielectric loss part of the signal losses. As molecular vibrations increase with increase in frequency, they cause higher losses in the dielectric. Materials that have a low dissipation factor exhibit lower levels of losses with increase in frequency.

Copper Loss

Eddy currents forming within the copper traces carrying time varying signals, cause skin effect, forcing most of the current flow to the outer surface of the trace. This effectively reduces the area through which the current flows, resulting in the signals facing higher resistance. Skin effect increases with higher frequencies. If the copper trace has a surface finish of nickel, most of the signals might flow through the nickel layer, increasing the signal loss.

Designers can reduce the skin effect by using wider traces, as this increases the cross-sectional area of the trace. But increasing the width of traces may not always be possible.

As most of the outer surface of the traces carry the signals, the roughness of the surfaces also affects the resistance and hence their losses. A smooth copper surface, therefore, reduces signal loss.

Designers must select the copper foil based on the following properties:

Thickness — Typically, the copper thickness varies from 0.3 mils (0.25 oz) to 7 mils (5 oz).

Purity — Electronic grade copper is around 99.7% pure.

Copper-dielectric Interface Profile — A low profile offers lower copper losses for signals at high frequencies.

Basic PCB Material Types

Depending on the loss factor and the speed of operation, there are four basic PCB material types:

Normal Loss and Normal Speed

These are the most common type of PCB materials available. Isola FR370HR and the FR-4 family of materials fall in this category. With higher dielectric losses, these materials also do not show a flat dielectric constant versus frequency. Therefore, these materials are good only up to a few gigahertz of digital or analog applications.

Medium Loss and Medium Speed

Exhibiting a somewhat improved flat dielectric constant with frequency and half the dielectric loss of normal speed materials, medium speed materials are suitable for applications nearing 10 GHz. A good example of this type of material is the Nelco N700-2 HT.

Low Loss and High Speed

With significantly low dielectric loss and flatter dielectric constant with frequency, these materials are suitable for applications operating between 10 – 30 GHz. Low loss and high speed materials also generate lower levels of unwanted electrical noise in comparison to other materials. An example of such a material is the Isola I-Speed.

Very Low Losses and Very High Speeds

These materials are suitable for applications in the RF/Microwave frequencies. They exhibit the least dielectric loss and the flattest dielectric constant with frequency. They are suitable for frequencies of operation from 20 GHz and above.

Types of Copper Foil

Rolled Copper Foil

Mostly used by fabricators for making flexible PCBs, this type of copper foil is very thin as they are processed by rolling them between heavy rollers. The smooth surface and the horizontal grain structure resulting from the rolling makes rolled copper very suitable for low loss and high speed PCBs.

Electro-Deposited Copper Foil

With a rough surface and vertical grain structure, this type of electro-deposited copper foil is useful for rigid PCBs operating with normal loss, normal speed applications.

Low-Profile Copper Foil

Organic additives or levelers added to the plating bath of electro-deposited copper foils help in reducing the roughness.

Best Practices in PCB Material Selection

- Select low moisture absorption materials
- Select CAF resistant materials
- Select substrates with a tight weave
- Always match the CTE
- Do not use FR4 for high frequency and high speed designs
- Follow IPC standards:
    - IPC-4101C — IPC standard specifications for PCB base materials for rigid, multi-layered boards.

- IPC-4103 — IPC standard specifications for PCB base materials for high-frequency/high-speed applications.
- IPC/JPCA-4104 — IPC standard specifications for PCB base materials for HDI and Microvia boards.
- IPC-4204 — IPC standard specifications for flexible and metal-clad substrates.

Conclusion

Eminent PCB manufacturers like Rush PCB Inc have been using specialty high-frequency/high-speed circuit materials for decades and for different reasons. These materials have several unique attributes as compared to that of the more traditional PCB materials. By understanding these attributes, OEMs and PCB fabricators can not only improve circuit performance, but also benefit greatly from them.

https://rushpcb.com/all-you-wanted-to-know-about-pcb-materials/

Text 5
Facts About Silicon

Silicon is the element to thank for the computer you're using to read these words. A crucial component in microelectronics and computer chips, this extremely common element is also responsible for warm, white beaches — silica, an oxide of silicon, is the most common component of sand.

Silicon is the seventh-most abundant element in the universe and the second-most abundant element on the planet, after oxygen, according to the Royal Society of Chemistry. About 25 percent of the Earth's crust is silicon. Besides computer chips, silicon has many uses; weirder spots where this element appears include menstrual cups, breast implants and oven mitts — in the form of silicone.

What makes silicon so special that is has an entire valley in California named after it? Read on.

Just the facts

- Atomic number (number of protons in the nucleus): 14
- Atomic symbol (on the Periodic Table of Elements): Si

- Atomic weight (average mass of the atom): 28.09
- Density: 2.3296 grams per cubic centimeter
- Phase at room temperature: Solid
- Melting point: 2,577 degrees Fahrenheit (1,414 degrees Celsius)
- Boiling point: 5,909 degrees F (3,265 degrees C)
- Number of isotopes (atoms of the same element with a different number of neutrons): 24
- Most common isotope: Si-28 (92 percent natural abundance)

Silicon the semiconductor

In nature, silicon is no loner. It's usually found linked up with a pair of oxygen molecules as silicon dioxide, otherwise known as silica. Quartz, an abundant ingredient in sand, is made up of non-crystallized silica.

Silicon is neither metal nor non-metal; it's a metalloid, an element that falls somewhere between the two. The category of metalloid is something of a gray area, with no firm definition of what fits the bill, but metalloids generally have properties of both metals and non-metals. They look metallic, but conduct electricity only intermediately well. Silicon is a semiconductor, meaning that it does conduct electricity. Unlike a typical metal, however, silicon gets better at conducting electricity as the temperature increases (metals get worse at conductivity at higher temperatures).

Silicon was first isolated in 1824 by Swedish chemist Jöns Jacob Berzelius, who also discovered cerium, selenium and thorium, according to the Chemical Heritage Foundation. Berzelius heated silica with potassium to purify silicon, according to the Thomas Jefferson National Accelerator Facility, but today the refinement process heats carbon with silica in the form of sand to isolate the element.

Silicon is a main ingredient in very low-tech creations, including bricks and ceramics. But the high-tech stuff is where the element really makes its mark. As a semiconductor, silicon is used to make transistors, which amplify or switch electrical currents and are the backbone of electronics from radios to iPhones.

Silicon is used in various ways in solar cells and computer chips, with one example being a metal-oxide-semiconductor field effect transistor, or MOSFET, the basic switch in many electronics. To make silicon into a transistor, the crystalline form of the element is adulterated with trace amounts of other elements, such as boron or phosphorous, according to Lawrence Livermore National Laboratory. The trace elements bond with the silicon atoms, freeing up electrons to move throughout the material, according to the University of Virginia.

By creating spaces of unadulterated silicon, engineers can create a gap where these electrons can't flow — like a switch in the "off" position.

To turn the switch to "on," a metal plate, connected to a power source, is placed near the crystal. When the electricity flows, the plate becomes positively charged. Electrons, which are negatively charged, are drawn to the positive charge, allowing them to make the leap across the pure-silicon segment. (Other semiconductors besides silicon can be used in transistors, as well.)

Who knew?

- When the Apollo 11 astronauts landed on the moon in 1969, they left behind a white pouch containing a silicon disc slightly bigger than a silver dollar. Inscribed in microscopic font on the disc are 73 messages, each from a different country, expressing wishes of goodwill and peace.
- Silicon isn't the same thing as silicone, that famous polymer found in breast implants, menstrual cups and other medical technology. Silicone is made of silicon along with oxygen, carbon and hydrogen. Because it resists heat so well, silicone has increasingly been used to make kitchen tools, such as oven mitts and baking sheets.
- Silicon can be dangerous. When inhaled over long periods of time, it can cause a lung disease known as silicosis.
- Love the iridescence of an opal? Thank silicon. The gemstone is a form of silica bound with water molecules.
- Silicon carbide (SiC) is almost as hard as a diamond, according to the Institute of Materials, Minerals, and Mining. It ranks a 9-9.5 on the Mohs hardness scale, slightly less than diamond, which has a hardness of 10.
- Plants use silicon to strengthen their cell walls. The element appears to be an important nutrient that helps confer resistance to disease,

according to a 1994 paper in the journal Proceedings of the National Academy of Sciences.

- Silicon Valley gets its name from the silicon used in computer chips. The nickname first appeared in 1971 in the newspaper "Electronic News."
- Silicon-based life, like the Horta from "Star Trek," may not be entirely science fiction, according to researchers from Caltech. Early research has shown that silicon can be incorporated into carbon-based molecules such as proteins.

Current research

Today's silicon research sounds just short of sci-fi: In 2006, researchers announced they had created a computer chip that melded silicon components with brain cells. Electrical signals from the brain cells could be transmitted to the electronic silicon components of the chip, and vice versa. The hope is to eventually create electronic devices to treat neurological disorders.

A 2018 study (opens in new tab) appearing in Nature tests a new type of quantum device made from silicon. Quantum computers may someday become the norm, outperforming current computer technology with the ability to perform calculations in parallel. Creating these devices using the same techniques to build traditional silicon chips could accelerate the development of these devices, potentially leading to new uses for quantum devices.

Silicon also has promise in the creation of incredibly tiny lasers called nanoneedles, which can be used to transmit data faster and more efficiently than traditional optical cables. Superconductor lasers shed heat much easier than glass lasers, said John Badding, a materials chemist at Penn State University. That means they can boast more power than traditional lasers.

Badding and his team are also working to create next-generation optical fibers that integrate superconductors instead of simply glass, he told Live Science.

"Semiconductors have a whole variety of properties that you just can't get with glasses," Badding said. Having semiconductor materials embedded in optical fibers would allow for mini-electronics included in these cables, which are crucial for sending information over long distances. Semiconductor cables would also allow for the manipulation of light in the fiber, Badding added.

Traditional silicon chips are made by depositing layers of the element on a flat surface, usually starting with a precursor gas such as silane (SiH_4) and allowing the gas to solidify, Badding said. Cables, on the other hand, are drawn. To make a glass fiber optic cable, you would begin with a glass rod, heat it and then draw it out like taffy, lengthening it into a long, skinny thread.

Badding and his colleagues have figured out a way to get semiconductors into this spaghetti-like shape. They use drawn-glass fibers with tiny holes and then compress gases such as silane under high pressures to force them into those spaces.

"It'd be like filling a garden hose that goes from Penn State to New York completely solid with silicon," Badding said. "You'd think things would get plugged up and messed up, but they don't."

The resulting semiconductor strands are three to four times thinner than a human hair. Badding and his team are also experimenting with other semiconductors, such as zinc selenide (zinc and selenium) to create fibers with capacities never seen before.

More About Silicon:

- For a fun and interesting look at the history of Silicon Valley, including information about the minds and products involved in the making of the high-tech startups, check out NPR's interactive Silicon Valley timeline.
- They may be close on the Periodic Table of Elements but silicon and carbon are different chemical beasts. Here's a look by Dow Corning on their differences, which boil down to one being organic and the other inorganic.
- HowStuffWorks has a great breakdown of how semiconductors work and how silicon is a major player.
- Want to find out how the famous Intel chips, made of silicon of course, are made? The tech company describes the history of their

chips, how they've changed over time, how they're made and how they work.
https://www.livescience.com/28893-silicon.html

Text 6
What is Soldering? A Full Guide (Meaning, Definition and Types)

Soldering is a joining process used to join different types of metals together by melting solder. Solder is a metal alloy usually made of tin and lead which is melted using a hot iron. The iron is heated to temperatures above 600 degrees fahrenheit which then cools to create a strong electrical bond.

How Does it Work?

Solder is melted by using heat from an iron connected to a temperature controller. It is heated up to temperatures beyond its melting point at around 600 degrees fahrenheit which then causes it to melt, which then cools creating the soldered joint.

As well as creating strong electrical joints solder can also be removed using a desoldering tool.

Solder is a metal alloy used to create strong permanent bonds; such as copper joining in circuit boards and copper pipe joints. It can also be supplied in two different types and diameters, lead and lead free and also can be between .032” and .062”. Inside the solder core is the flux, a material used to strengthen and improve its mechanical properties.

What Metals are Used?

Filler metals used in soldering were once lead based (lead solder), however, owing to regulations, lead-based solders are increasingly replaced with lead free solders, which may consist of antimony, bismuth, brass, copper, indium, tin or silver.

Which Flux Can be Used for Soldering?

Occasionally at the site of the joint, there are impurities such as oil, dirt or oxidation, the flux helps prevent oxidation and can sometimes chemically clean the metal. The flux used is **rosin flux** which helps the mechanical strength and electrical contact of electrical joints. Sometimes it is also possible to apply a 'wetting agent' to reduce the surface tension.

Types of Soldering

There are three types of soldering which use increasingly higher temperatures, which in turn produce progressively stronger joints:

- **Soft soldering (90 °C - 450 °C)** - This process has the lowest filler metal melting point of all the soldering types at less than around 400°C these filler metals are usually alloys, often containing lead with liquidus temperatures under 350°C. Because of the low temperatures used in soft soldering it thermally stresses components the least but does not make strong joints and is then therefore unsuitable for mechanical load-bearing applications. It is also not suited for high temperature use as this type of solder loses strength and melts.
- **Hard (silver) soldering (>450 °C)** – Brass or silver is the bonding metal used in this process, and requires a blowtorch to achieve the temperatures at which the solder metals.
- **Brazing (>450 °C)** – This type of soldering uses a metal with a much higher melting point than those used in hard and soft soldering. However, similarly to hard soldering, the metal being bonded is heated as opposed to being melted. Once both the materials are heated sufficiently, you can then place the soldering metal between them which melts and acts as a bonding agent.

Uses of a Soldering Iron

A soldering iron is a **hand tool used to heat solder**, usually from an electrical supply at high temperatures above the melting point of the metal alloy. This allows for the solder to flow between the workpieces needing to be joined.

This soldering tool is made up of an insulated handle and a heated pointed metal iron tip. Good soldering is influenced by how clean the tip of your soldering iron is. To maintain cleanliness, a user will hold the soldering iron and use a wet sponge to clean the soldering iron tip prior to soldering components or making soldered connections.

In addition to the soldering iron, s*older suckers* are an important part of the soldering setup. If excessive solder is applied, these small tools are used to remove the solder, leaving only that desired.

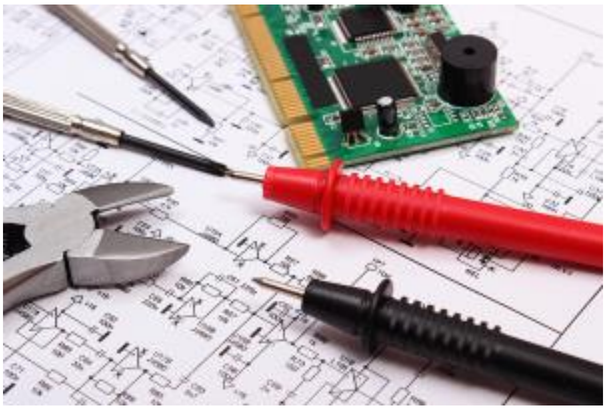
What is a Soldering Gun Used For?

Soldering guns are used for applications where more heat is required as irons use lower power. This tool is used for joining stained glass, light sheet metal and heavy electronic soldering work. When you need to solder intermittently, the soldering gun is much more practical as it cools much quicker.

https://www.twi-global.com/technical-knowledge/faqs/what-is-soldering

Text 7
CAD / CAM / CAE technologies

The acronym **CAD comes from the English expression *Computer Aided Desig***n. It involves the use of computer technology to aid in the design of a product. In the case that concerns us now, it would involve designing housings for communications devices. In short, CAD is the **drawing or graphical tool that replaces the traditional drawing board** in drafting the design object.



CAD, CAM, CAE

CAM is an acronym for another English expression, ***Computer Aided Manufacturing*.** This system uses computers in the product manufacturing process, making it as fully automated as possible. With some of the newest CAM systems today, we are talking about a process that includes machining, forming, assembly, storage, right up to the final shipping of the product.

This brings me to the last term I want to talk about here, CAE, an abbreviation of the expression Computer Aided Engineering. This tool

links the CAD and CAM processes. It uses CAD geometry as a starting point on which to apply a series of operating and work simulation and analysis processes aimed at **improving the quality, reliability and competitiveness** of the product. It then generates information that CAM needs to manufacture the piece through numeric control systems.

Any modern product design and manufacturing process currently requires the creating company to use and integrate these technologies – which have come to optimize all manufacturing steps from the initial conception right up to when the product is finally made available to the desired client.

Incorporating these processes will necessitate raising the qualitative level of the personnel using them. This will also result in optimizing manufacturing and the end quality of the product.

Optimization and cost reduction

These techniques have improved exponentially in recent years due to **advances in microelectronics,** hardware and software. By feeding each other technology, CAD, CAM and CAE are also instrumental in the development of the microelectronics and hardware fields.

CAD/CAM/CAE is more than just a design and manufacturing tool. By optimizing these processes, it helps **reduce manufacturing times, and thus product costs.**

The effetiveness of these tools is demonstrated by the fact that a wide range of different industries have incorporated them to help with their projects. The **aeronautical, automobile, heavy industries, architecture, civil engineering** and a whole host of other industries rely on this technology to achieve the highest possible levels of quality.

https://www.teldat.com/blog/cad-cam-cae-microelectronics-to-increase-quality/

Text 8
What jobs can you do with an electronic engineering degree?

Careers for electronic engineering graduates can be found in a range of industries, from automotive to utilities. Electronic engineers are also sought by IT companies.

An electronic engineering degree appears to lead in some fairly obvious directions – to the electronics industry, for example. However, the options are much broader than this, both within the engineering industry and outside it.

Electronic engineering graduates are typically sought by the following industries. However, different employers will have different requirements, so do check out companies individually.

- Aerospace industry
- Automotive industry
- Defence industry
- Electronics industry
- Fast-moving consumer goods industry
- Marine industry
- Materials and metals industry
- Power generation industry
- Rail industry
- Utilities industry
- IT industry

Electronic engineering graduates in the aerospace industry

"A graduate electronic engineer in the aerospace industry would be working on cutting edge technology, introducing or enhancing power-dense electrical controllers and electronics across the Rolls-Royce business sectors. Also, an increasing focus is on emerging technologies for hybrid/electric propulsion for aerospace platforms." *Eddie Orr, chief of sector for **Rolls-Royce** Electrical*.

Electronic engineering graduates in the automotive industry

Electronics is now an important part of the automotive industry and there is a big call for power electronics skills. Electronic engineers will work on a variety of systems including engine control units, dashboard indicators, air conditioning, safety systems, braking systems and infotainment systems. Their skills set is also needed for the development of autonomous, connected and electrified (ACE) vehicles.

Electronic engineering graduates in the defence industry

"Electronic engineers in the defence industry optimise hardware and software design concepts, develop sophisticated design processes and test complex products to ensure the equipment is fit for air, sea or land operating environments. Activities could include: circuit design, assessment of equipment behaviour, fault diagnosis, assessment of new technologies and components, simulation and modelling, and data analysis." *Pamela Wilson, engineering manager at **BAE Systems***.

Electronic engineering graduates in the electronics industry

A graduate electronic engineer in the electronics sector could work in roles such as design engineering (designing a product or component prior to launch) or applications engineering (supporting a product for its entire life). They may work with chips, integrated circuits, components such as capacitors and resistors, and devices that use electricity as part of their source of power.

Electronic engineering graduates in the fast-moving consumer goods industry

"Most of the graduate roles in the fast-moving consumer goods industry are in one of two areas: manufacturing/engineering or supply networking operationss/logistics. For both of these areas, the work is not defined in nice separate buckets of mechanical, electrical, chemical etc but is normally a mixture of different engineering disciplines as a general manufacturing or logistics engineer. Graduates will pick up skills from other disciplines as they go through their training and career." *Chris Traynor, careers adviser and former engineer and engineering recruiter*.

Electronic engineering graduates in the marine industry

Engineers in the marine industry usually either operate and maintain vessels or design and build them. An electronic engineer could be working on radar systems for warships or complex automation systems, reducing manning requirements at sea and tackling demands to reduce pollution and lower the cost of operation.

Electronic engineering graduates in the materials and metals industry

"An electronic engineer in the materials and metals industry will be maintaining the control and instrumentation in place and optimising hardware and software design concepts. Activities could include fault diagnosis, simulation and modelling and data analysis. They could well be designing and running a control system for a power station, for example." *Peter Toms, senior engineering manager at **Tata Steel**.*

Electronic engineering graduates in the power generation industry

An electronic engineer in the power generation industry will often be involved in designing, building and maintaining control and instrumentation plant items such as SCADA (supervisory control and data acquisition) DCS (distributed control systems), instruments, telephony and data networks.

Electronic engineering graduates in the rail industry

"An electronic engineer in the rail industry could work in a number of areas, including signalling power, point heating and lighting. Their job will involve writing specifications for power distribution systems, reviewing designs and answering technical queries. On the maintenance side, they will be going out onto the rail network to test equipment or replace components.'" *Elen Jones, programme engineering manager at **Network Rail**.*

Electronic engineering graduates in the utilities industry

Electronic engineers in the utilities sector can work in telecoms and energy, e.g. designing and running a control system for a nuclear power station.

Electronic engineering graduates in the IT industry

Electronic engineering graduates are often welcome to apply for technical roles in the IT industry. Don't assume that only computer scientists or software engineers are sought.

Non-engineering jobs for electronic engineering students

If you're keen to explore career paths outside engineering, start by reading What can I do with an engineering degree, apart from being an engineer? You can remain in the engineering industry but take on a more commercial role. Most engineering employers recruit graduates for roles in HR, finance and supply chain, to name just a few.

Or if you'd like to take a completely new career direction, there are plenty of options. In particular, you might like to consider options such as consulting, law (eg intellectual property law), financial services, sales and pre-sales, education, which are areas in which you can put your analytical skills and high levels of numeracy to good use. You could also put your background to good use in careers such as science journalism or technical publishing.

Appendix 2

GRAMMAR REFERENCES

1. Passive Voice

The Passive Voice is used to show interest in the person or object that experiences an action rather than the person or object that performs the action. In other words, the most important thing or person becomes the subject of the sentence.

Sometimes we use the passive voice because we don't know or do not want to express who performed the action.

The passive voice is often used in formal texts.

If we want to say who or what performs the action while using the passive voice, we use the preposition *by*.

To clean / to build, Passive Voice

Subject + to be (conjugated)	**+ past participle**	**+ rest of sentence**
Simple present		
The house is	Cleaned / built	every day.
Present continuous		
The house is being	cleaned / built	at the moment.
Simple past		
The house was	cleaned / built	yesterday.
Past continuous		
The house was being	cleaned / built	last week.
Present perfect		
The house has been	cleaned / built	since you left.
Past perfect		
The house had been	cleaned / built	before they arrived.
Future		
The house will be	cleaned / built	next week.
Future continuous		
The house will be being	cleaned / built	tomorrow.

2. Modal verbs

Learn about modal verbs and their different meanings.

The modal verbs: *can – could, may – might, must, shall – should, will –would*

We use modals to show if we believe something is certain, possible or impossible: *My keys **must** be in the car. It **might** rain tomorrow. That **can't** be Peter's coat. It's too small.*

We also use them to do things like talk about ability, ask permission, and make requests and offers: *I **can't** swim. **May** I ask a question? **Could** I have some tea, please? **Would** you like some help?*

Possibility

We use ***may, might and could*** to say that something is possible, but not certain: *They **may** come by car. (= Maybe they will come by car.)*

*They **might** be at home. (= Maybe they are at home.)*

*If we don't hurry, we **could** be late. (= Maybe we will be late.)*

We use ***can*** to make general statements about what is possible:

It ***can*** be very cold here in winter. (= It is sometimes very cold here in winter.)

You ***can*** easily get lost in this town. (= People often get lost in this town.)

Ability

We use ***can*** and ***can't*** to talk about someone's skill or general abilities: She ***can*** speak several languages. He ***can*** swim like a fish. They ***can't*** dance very well.

We use ***can*** and ***can't*** to talk about the ability to do something at a specific time in the present or future: I ***can*** see you. Help! I ***can't*** breathe.

We use ***could*** and ***couldn't*** to talk about the past: She ***could*** speak several languages. I ***couldn't*** see you.

Permission

Asking for permission

We use ***can*** to ask for permission to do something: ***Can*** I ask a question, please? ***Can*** we go home now?

Could is more formal and polite than can: ***Could*** I ask a question, please? ***Could*** we go home now?

May is another more formal and polite way of asking for permission: ***May*** I ask a question, please? ***May*** we go home now?

Giving permission

We use ***can*** to give permission: You ***can*** go home now. You ***can*** borrow my pen if you like.

May is a more formal and polite way of giving permission: You ***may*** go home now.

We use ***can*** to say that someone has permission to do something: We ***can*** go out whenever we want. Students ***can*** travel for free.

May is a more formal and polite way of saying that someone has permission: Students ***may*** travel for free.

Refusing permission

We use ***can't*** and ***may not*** to refuse permission or say that someone does not have permission: You ***can't*** go home yet. Students ***may not*** travel for free.

Requests

We use ***could you*** … and ***would you*** … as polite ways of telling or asking someone to do something: ***Could you*** take a message, please? ***Would you*** carry this for me, please?

Can and ***will*** are less polite: ***Can*** you take a message, please? ***Will*** you carry this for me, please?

Offers and invitations

We use ***can I*** … to make offers: ***Can I*** help you? ***Can I*** do that for you?

We can also use ***shall I*** …: ***Shall I*** help you with that? ***Shall I*** call you on your mobile?

We sometimes say ***I can*** ... or ***I could*** ... or ***I'll*** (***I will***) ... to make an offer: I ***can*** do that for you if you like. ***I could*** give you a lift to the station. ***I'll*** do that for you if you like. ***I'll*** give you a lift to the station.

We use ***would you like (to)*** ... for invitations: ***Would you like to*** come round tomorrow? ***Would you like*** another drink?

Suggestions

We use ***should*** and ***shouldn't*** to make suggestions and give advice: You ***should*** send an email. You ***shouldn’t*** go by train.

We also use ***could*** to make positive suggestions: We ***could*** meet at the weekend. You ***could*** eat out tonight.

3. The infinitive

The infinitive is a verbal form (a non-finite verb form) which consists of the base form of the verb with the particle "to": *to do; to go; to play; to take; to break; to find*.

The English infinitive and the Russian non-finite verb form have similar features. At the same time, the infinitive in English has a number of peculiarities which make using the infinitive difficult for language learners.

Properties and functions of the infinitive

The infinitive has some properties of the verb. The infinitive names an action (*to drive a car*) or state (*to be sick*), but cannot show person, number, or mood. The infinitive has active and passive forms (*to take; to be taken*) and can express voice and time, though in a rather limited way.

The infinitive can have a direct object (*He plans to visit a museum*) or a prepositional object (*He wants to know about it*) and can be modified by an adverb (*He tried to walk slowly*).

The infinitive can be part of the compound verbal predicate (*She can drive; We must go*) or part of the compound nominal predicate (*His aim is to help you*). The infinitive alone, without another verb, is generally not used as the predicate.

The infinitive has some properties of the noun and can be in the function of the subject (*To quit now would be a mistake*) or of an object (*He likes to sing; She asked me to wait*). The infinitive can be in the function of an attribute (*He has no desire to see them*).

The infinitive can function as an adverbial modifier of purpose (*He came here to study*) or as an adverbial modifier of consequence (*He was too tired to go to the cinema*).

Use of particle "to"

As a rule, the infinitive is preceded by the particle "to".

The particle "to" is omitted after modal verbs (*You can go; You must take it*), after the verbs "make, let" (*Make him eat; Let her play*), after the verb "help" in American English (*Help me find my book*), and in constructions like "*She saw him leave; He heard her sing*". The infinitive without the particle "to" is called bare infinitive.

If the verbs "make, help, see, hear" in such constructions are used in the passive voice, the infinitive after them keeps the particle "to": *He was made to leave. She was helped to do it. He was seen to enter that building. He was heard to laugh.*

If there are two infinitives next to each other connected by "and, or, but, except, than", the second infinitive is often used without "to": *I told him to sit down and rest. She didn't know whether to go or stay. There was nothing to do but wait. There is nothing for him to do but watch TV. It's easier to type than write.*

But it is often necessary to repeat "to" before the second infinitive for clarity, especially in longer infinitive phrases: *I told him to sit down on the sofa and to rest a little. It is easier to type this text than to write it. To buy or not to buy is a hard choice for her.*

The particle "to" is often used without the infinitive at the end of the sentence if the infinitive is clearly mentioned earlier in the sentence: *He asks me to do this work, but I don't want to. I didn't want to go there, but I had to. He would prefer to sleep till noon if he were allowed to.*

(The place of the particle "to" is also described in the part "Split infinitive" at the end of this article.)

How infinitives express time

The finite verb forms express the time of the action in the present, past, or future. For example: *He works in a bank. He worked yesterday. He will work tomorrow.*

The infinitive can express time only relatively, i.e., in relation to the action expressed by the verb in the predicate.

The action indicated by the infinitive can be simultaneous with the action expressed by the verb in the predicate: *He seemed to be sleeping. He is trying to work.*

The action indicated by the infinitive can precede the action expressed by the verb in the predicate: *The rain seems to have stopped. It is nice to have talked to you.*

The action of the infinitive later than the action of the verb in the predicate is understood from the context and meaning: *He intends to do it tomorrow. The goods are to be delivered next week.*

Forms of the infinitive

The infinitive has the following active and passive forms: simple (to write), continuous (to be writing), perfect (to have written), perfect continuous (to have been writing), simple passive (to be written), perfect passive (to have been written). The examples below illustrate the use of the infinitive forms in sentences.

I asked him to write a report.

He is supposed to be writing a report now.

He appears to have written a report already.

He seems to have been writing a report for two hours already.

I expect his report to be written tomorrow.

I expect his report to have been written by now.

Simple active and passive forms are the most common. Compound (analytical) forms of the infinitive are not used very often in general speech and writing.

More examples with perfect and passive forms:

He is said to have sold all his houses.

She was sorry to have said it.

He is known to have been working in this field for many years.

He wants to be informed about any problems immediately.

He asked to be informed of their arrival.

She is lucky to have been given such an opportunity.

All of the infinitive forms are used with modal verbs in order to express certain meanings of modal verbs. For example:

He can write reports.

He must be writing a report now.

He should have written a report yesterday.

This report might have been written by one of our freelance workers.

Typical constructions with infinitives

Typical constructions in which the infinitive is used are described below, with examples of use.

Only the most common verbs after which the infinitive is used are included in the lists of verbs in this material. Note that the verbs after which the infinitive is used may be found in more than one construction. For example: *I expect to arrive tomorrow. – I expect her to arrive tomorrow. – She is expected to arrive tomorrow.*

Bear in mind that some of the verbs listed in this material may be followed by infinitives or gerunds. For example: *He likes to read.* – He likes reading.

Verb + infinitive

In this construction the infinitive stands immediately after the verb, usually after the following verbs: <u>afford, agree, appear, ask, beg, begin, continue, decide, deserve, expect, fail, forget, hate, hesitate, hope, intend, learn, like, love, manage, mean, need, offer, plan, prefer, prepare, pretend, promise, refuse, regret, remember, seem, start, threaten, try, want, would like</u>.

The infinitive is an object after most of the verbs of this group. The infinitive after the linking verbs "appear, seem" is a complement, i.e. part of a compound nominal predicate. In some sources, the infinitive after "appear, seem" is regarded as part of a compound verbal predicate.

He hopes to see them soon.

His daughter is learning to drive.

I need to talk to him.

She forgot to lock the door.

He refused to help them.

I want to go home.

He appears to be tired.

She seems to like her job.

The continuous infinitive (emphasizing duration of the action) and the perfect infinitive (indicating the preceding action) are rather often used after the verbs "seem, appear, pretend".

He pretended to be reading.

The weather seems to be improving.

He seems to have lost weight.

He appears to have forgotten about it.

Note the use of the passive infinitive in those cases where the person indicated in the subject undergoes the action of the infinitive (i.e., that person does not perform the action himself / herself).

She doesn't like to be disturbed during her work.

I would like to be invited to the party.

Note: Particle NOT

Depending on the meaning of the sentence, NOT can be used with the verb in the predicate or with the infinitive.

He did not promise to do it.

He promised not to do it.

Don't even try to lie to me.

Try not to be late.

They decided not to go to the party.

Note: Gerunds

The verbs "begin, continue, forget, hate, like, love, prefer, regret, remember, start, try" are also used with a gerund, with or without a change of meaning. Compare: *He began to eat. – He began eating. I remembered to lock the door. – I remember locking the door*.

Verb + object + infinitive

The constructions Verb + object + infinitive are divided into four groups here according to the type of construction and the meaning that these constructions convey after certain verbs. The infinitive functions as an object in such constructions and stands after another object expressed by a noun or a pronoun.

Group 1

In this construction, the infinitive is used after the verbs "advise, allow, ask, beg, convince, encourage, forbid, force, help, hire, instruct, invite, let, make, order, permit, persuade, remind, teach, tell, urge, warn". Note that the infinitive is used without the particle "to" after the verbs "make, let" (and "help" in AmE).

The doctor advised him to rest for a few days.

He asked her to speak slowly.

She helped me to wash the windows.

It makes me think that he is lying.

She reminded him to buy cheese.

He taught me to drive.

She told me not to invite them.

Note: Gerunds

The verbs "advise, allow, forbid, permit" can be followed by a gerund directly. Compare: *She doesn't permit me to use her computer. – She doesn't permit using her computer*.

Group 2

In this construction, the infinitive is used after the verbs "want, would like, require, rely on, count on, expect, consider, find".

I *want you to do something for me.*

I count on you to do it quickly.

We expected Mike to be present at the meeting.

She found him to be a very nice person.

Note the use of the passive infinitive in those cases where the person indicated in the object undergoes the action of the infinitive (i.e., that person does not perform the action himself / herself).

She wants him to be elected.

I would like him to be invited to the party.

Group 3

In this construction, the infinitive without "to" is used after the verbs of sense perception "hear, see, watch, observe, notice, feel".

I saw him cross the street.

I watched him plant the roses.

I heard her cry.

The present participle is used instead of the infinitive in such constructions to stress that the action is in progress. For example: I saw him crossing the street. I heard her singing.

Group 4

This construction with the verbs "have" and "get" has causative meaning, i.e., "have" and "get" here generally mean "induce someone to do something; ensure that someone does something", with "have" close in meaning to "ask" and "get" close in meaning to "persuade". The infinitive is used without the particle "to" after "have", but with "to" after "get".

Have him send the letters.

I had my sister watch the baby while I was out.

Get your son to clean the carpet.

I got my brother to help me (to) repair my car.

The past participle is used after the verbs "have" and "get" in constructions like "I had my car washed" which indicate that the action is performed for you by someone.

Note: Complex object

Constructions after the verbs in Groups 2, 3, 4 are often called "complex object" in Russian materials on English grammar.

Infinitives after passive verb forms

Many verbs can be used in the passive voice with the infinitive in the function of an object after them.

The infinitive is used after the passive forms of the verbs "allow, permit, ask, tell, order, force, advise, warn, encourage". Compare active and passive constructions:

She allowed us to go there. – We were allowed to go there.

They warned me not to do it. – I was warned not to do it.

He advised her to find a good lawyer. – She was advised to find a good lawyer.

The infinitive is used after the passive forms of the verbs "say, report, expect, suppose, allege, believe, know".

Prices are expected to rise even higher.

He was expected to visit them.

She was supposed to arrive at 10 a.m.

You are not supposed to be here.

He is said to be 125 years old.

He is believed to be the oldest person in the country.

Such constructions containing simple, continuous, perfect, or passive forms of the infinitive are often used in news reports. For example:

The committee is expected to approve this initiative.

The commission is reported to be conducting an investigation of the incident.

He is alleged to have stolen more than ten million dollars.

Several people are reported to have been injured in the fire.

Infinitive after linking verb BE

The infinitive after the linking verb BE is part of the compound nominal predicate.

His aim was to help them.

Your duty is to study.

Your task is to do these exercises.

His assistant's main task is to gather information for research.

His sole desire is to be accepted in their circle.

Infinitives after "how, what, where"

The infinitive as an object is often used after "how, what, who, whom, which, when, where, whether", usually after the verbs "know, ask, tell, advise, explain, show, decide, wonder, understand".

I don't know what to say.

I don't know who to ask.

Show me how to do it.

I haven't decided yet whether to go there or not.

The tour guide told us where to find interesting souvenirs.

Infinitives after adjectives

The infinitive as an object is used after many adjectives and participles, for example, after "able, afraid, amused, anxious, ashamed, astonished, careful, delighted, determined, disappointed, eager, free, frightened, glad, grateful, happy, interested, lucky, pleased, prepared, proud, ready, relieved, reluctant, sad, shocked, sorry, surprised, terrified, willing".

This construction is often used to describe people's feelings in relation to the action expressed by the infinitive.

She is afraid to go there alone.

We are ready to start.

You were lucky to find that book.

She was reluctant to go.

He is eager to be invited to the show.

The infinitives "to hear, to see, to learn, to discover, to find" are often used after the adjectives "glad, happy, delighted, disappointed, surprised, sorry".

She was glad to hear that.

He was happy to see her.

I was sorry to hear about their divorce.

I was surprised to learn that she had quit her job.

Infinitives as attributes

The infinitive as an attribute always stands after the noun (or indefinite pronoun) that it modifies. For example:

Can you give me a book to read?

I have a lot of work to do today.

Give him something to eat.

He has nowhere to go.

Infinitives as attributes are used after many nouns, for example, after "ability, advice, attempt, capacity, chance, command, decision, desire, eagerness, effort, excuse, failure, intention, invitation, necessity, need, offer, opportunity, order, permission, power, promise, reason, recommendation, refusal, reluctance, right, time, way, willingness, wish".

Her ability to memorize words is amazing.

I have no intention to work there.

She has no desire to get married.

There's no need to hurry.

They had every reason to believe that he had left the country.

Note: The gerund is also used after some of these nouns (for example, after "chance, intention, necessity, reason"), with or without a change in meaning. (See The Gerund in the section Grammar.)

Infinitives in constructions after formal subject IT

The infinitive may be used as the subject of the sentence. For example:

To find him was difficult.

To know the rules is necessary.

To ask him for help was a mistake.

However, it is more common to use the construction in which the pronoun IT is the formal subject, and the infinitive is placed after the predicative adjective or noun.

It was difficult to find him.

It is necessary to know the rules.

It was a mistake to ask him for help.

The infinitive in this construction is often used after the following adjectives and participles: advisable, amazing, awful, bad, convenient, careless, correct, cruel, dangerous, desirable, difficult, easy, foolish, funny, good, great, hard, helpful, important, impossible, interesting, intolerable, natural, necessary, nice, pleasant, possible, reasonable, ridiculous, silly, strange, surprising, terrible, unbearable, undesirable, unnecessary, unpleasant, unreasonable, useful, useless, wise, wonderful, wrong.

It is nice to meet you.

It is useless to talk to him.

It is hard to be a doctor.

It was dangerous to stay there.

The infinitive in this construction is used after various nouns, for example, after "duty, fun, idea, mistake, pleasure, surprise, thing, time".

It's a good idea to invite John.

It is time to leave.

It was a surprise to hear such words.

It was a terrible thing to say.

FOR + noun / pronoun + infinitive

The action indicated by the infinitive usually refers to the subject or to the object. Compare: I'm planning to visit her. – I asked him to visit her.

In some sentences, the action indicated by the infinitive does not refer either to the subject or to the object: For example: It is pleasant to walk in the park. The tea was too hot to drink.

If it is necessary in such sentences to indicate the person to whom the action of the infinitive refers, add "for + noun / pronoun" before the infinitive. For example: It is pleasant for me to walk in the park. The tea was too hot for the children to drink.

Examples:

It was important for Victor to be present at the meeting.

It is difficult for him to live alone.

It is easy for her to learn English.

The first thing for you to do is to find Tom.

This is not for us to decide.

In some cases, "of + noun / pronoun" is used before the infinitive to indicate the person to whom the action of the infinitive refers. For example: It was very nice of you to bring her flowers. It was inconsiderate of him to ask her such questions.

Infinitive of purpose

The infinitive is often used as an adverbial modifier of purpose. In this function the infinitive may be preceded by "in order" or "so as".

He went to London in order to study English.

She came here to study.

I went out to buy bread and milk.

He did it to help her.

Press Enter to start the installation.

For emphasis, the infinitive of purpose is sometimes placed at the beginning of the sentence.

To understand his stories, you need to know where he grew up.

Infinitive of consequence

The infinitive is also used as an adverbial modifier of consequence, with the adverbs "too" and "enough".

I was too tired to notice it.

It is too late to call him now.

He is too young to be a manager.

She is old enough to understand it.

I don't know this subject well enough to discuss it with you.

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4. The Participle

Formation and use of English participles, main constructions with participles and various questions related to participles are described in this material.

Main points

English verbs have two participles: the present participle (typing, writing) and the past participle (typed, written).

Participles have some qualities of verbs and are used in the formation of the continuous, perfect and perfect continuous tenses (he is typing; he has written a letter).

Participles have some qualities of adjectives and are used as attributes in a sentence (a smiling girl; surprised faces).

Participles are also used in the function of adverbial modifiers (he opened the door, smiling; surprised, he didn't know what to say).

A participle construction, that is, a participle together with the words closely connected with it, can function as an attribute (the girl sitting at the table) or as an adverbial modifier (standing by the window, she watched the birds). Participle constructions (participial constructions) are usually called "participial phrases" or "participial clauses" in English grammar materials.

English participles are translated into Russian with the help of verbs, adjectives, participles, adverbial participles. Russian adverbial participle has no corresponding form in English.

Formation of participles

Present participle

The present participle is formed by adding "ing" to the base form of the verb: flying, playing, running, sleeping, working.

The present participle expresses active meaning: doing, flying, playing, reading, running, sleeping, taking, typing, working, writing.

Past participle

Regular verbs form the past participle by adding "ed" to the base form of the verb: moved, played, stopped, typed.

Irregular verbs form the past participle mostly by changing the root of the word: broken, flown, read, sold, taken, written.

The past participle expresses passive meaning: done, moved, played, read, sold, stopped, taken, typed, written.

Formation of tenses

The main function of participles is their use in the formation of certain tenses. Only the simple forms of participles (for example, writing, written) are used in the formation of tenses. The participle is part of the tense form; the participle together with the auxiliary verb is translated into Russian as a tense (not as a participle).

Present participle

The present participle (of the main verb) is used in the formation of the continuous and perfect continuous tenses. Examples:

Continuous tenses: He is working now. We were sleeping when he called. She will be writing letters at four o'clock.

Perfect continuous tenses: He has been working since early morning. She had been sleeping for two hours when you called. By six o'clock, she will have been writing letters for three hours.

Past participle

The past participle (of the main verb) is used in the formation of the perfect tenses in the active voice and of all of the tenses in the passive voice. Examples:

Perfect tenses: We have already written three stories. She had typed two reports by ten o'clock yesterday. She will have typed the next report by six o'clock.

Tenses in the passive: Three stories have already been written. Five reports were typed last week. Two reports had been typed by ten o'clock yesterday. This report will be typed tomorrow.

Participles after the verb BE

Participles are used in the formation of certain tenses. Participles are also used in the function of adjectives. Usually, the difference between these functions of participles is clear and does not lead to mistakes in understanding. But in some cases, especially in those cases where a participle stands after the verb BE, it may be a little difficult to understand the difference. Compare these sentences:

This situation is humiliating. (the participle "humiliating" as an adjective)

Stop it! You are humiliating him. ("are humiliating" – the present continuous tense)

Two chairs are broken. (the participle "broken" as an adjective)

Two chairs were broken by some customers yesterday. ("were broken" – the simple past in the passive)

Forms of participles

Let's look at the forms of the participles using the verb "do" as an example. Like other verbs, the verb "do" has two participles: the present participle "doing" and the past participle "done".

Participles have simple and compound forms. Simple forms consist of only one word, i.e., the participle itself: doing, done. The form "doing" is simple active; the form "done" is simple passive.

Compound (analytical) forms are formed with the help of the auxiliary verbs "be" and "have": having done; being done; having been done. The form "having done" is perfect active; the form "being done" is passive; the form "having been done" is perfect passive.

Simple forms of participles are used in the formation of the tenses. In a sentence, simple forms of participles are also used in the function of attributes and adverbial modifiers. Compound forms of participles are used more rarely.

Examples of simple and compound forms

The sentences below contain simple and compound forms of participles. (Simpler sentences are indicated in parentheses.)

The boy is reading a book.

The reading boy didn't pay any attention to the teacher's words.

The boy reading a book didn't pay any attention to the teacher's words.

He was sitting by the window, reading a book.

Having read ten pages of the book, he decided to have a break. (After reading ten pages of the book, he decided to have a break.)

The books read by him last week included several fairy tales.

The story being read by him now is called "The Wonderful Wizard of Oz". (The story that he is reading now is called "The Wonderful Wizard of Oz".)

Published in 1900, the story was adapted into a film in 1939.

Having been translated into several languages, this story is well known in many countries. (Translated into several languages, this story is well known in many countries.)

Translation of participles

Depending on the function in the sentence, on the context and meaning, English participles are translated into Russian as participles, as adjectives, as adverbial participles, as verbs. Compare these examples:

I saw a running boy.

He was running very fast.

He ran shouting something.

Running past the bakery, the boy stopped abruptly.

He stood there, looking at the shopwindow intently.

Having found the door locked, the boy left.

Note: Adverbial participles

In the examples above, "shouting something; running past the bakery; looking at the shopwindow; having found" have been translated into Russian with the help of adverbial participles.

There are no adverbial participles in English. We translate English participles into Russian with the help of suitable adverbial participles in those cases where it is required by the norms of the Russian language.

Participles as attributes

Participles in the function of adjectives, that is, in the function of attributes in a sentence, are sometimes called "participial adjectives" in English grammar materials.

Participles can modify the subject, an object, or another noun in a sentence. Participles may stand before or after the noun that they modify. Participle constructions stand after the nouns that they modify.

Participle before noun

A single participle often stands before the noun that it modifies: a flying bird; a moving train; a promising actor; a growing interest; overwhelming majority, running water; boiling water; working people; a broken heart; a rotten apple; spoken language; a tired voice; a written confirmation; boiled water; developed countries; experienced users. Examples:

Barking dogs seldom bite.

I'm always glad to see her smiling face.

She spoke in a trembling voice.

He stood before the locked door.

He is a retired colonel.

Participle after noun

Not all participles can stand before their nouns. Participles that are closer to verbs than to adjectives are often placed after the nouns that they modify: the problems remaining; the people attending; the people involved; the questions discussed; the names mentioned; the documents required; those invited; those concerned.

In such cases, you can use a participle construction instead of a single participle. A participle construction expresses the same meaning as a relative subordinate clause (attributive clause).

Compare these sentences containing a single participle, a participle construction, or a relative clause:

The questions discussed were quite important. – The questions discussed at the meeting were quite important. – The questions that were discussed at the meeting were quite important.

Some of those invited refused to participate. – Some of those invited to the meeting refused to participate. – Some of the people who were invited to the meeting refused to participate.

Participle construction after noun

Participle constructions in the function of attributes stand after the nouns that they modify. For example:

The boy playing with the kitten is my nephew. (The boy who is playing with the kitten is my nephew.)

I talked to several people participating in the project.

The car parked by the entrance belongs to the director.

I need a list of the goods sold yesterday.

Active and passive meanings of participles

In the function of attributes, present participles express active meaning, and past participles express passive meaning.

In a number of cases there are no corresponding Russian participles with active and passive meaning, for example, in the case of "boring, bored". Compare these sentences:

His attitude is annoying.

She looks annoyed.

It was surprising that he went there.

I was surprised that he went there.

It was a boring party.

Everyone was bored.

I am bored. – Watch a film or read a book.

There are many pairs of frequently used participles with active and passive meaning: alarming, alarmed; astonishing, astonished; convincing, convinced; disappointing, disappointed; exciting, excited; exhausting, exhausted; frightening, frightened; humiliating, humiliated; horrifying, horrified; irritating, irritated; shocking, shocked.

Note: We translated the participles as participles to show the difference between active and passive meanings. Some participles are often translated as adjectives, for example, "alarming, convincing, humiliating".

More examples for memorizing: amazing, amazed; amusing, amused; charming, charmed; confusing, confused; depressing, depressed; developing, developed; disgusting, disgusted; embarrassing, embarrassed; encouraging, encouraged; fascinating, fascinated; frustrating, frustrated; pleasing, pleased; puzzling, puzzled; relaxing, relaxed; satisfying, satisfied; terrifying, terrified; thrilling, thrilled; tiring, tired; worrying, worried.

Some past participles in the function of attributes can express active meaning. For example: advanced students; experienced users; developed countries; increased activity.

Intensifiers with past participles

The adverbs "very, much, very much" intensify the meaning. "Very" is used with adjectives (and with adverbs, e.g., very quickly); "much" and "very much" are used with verbs. For example, you can say "This book is very good" and "I liked it very much", but you can't say "I very liked it".

Past participles, usually in the position after the verb BE, may also be used with intensifiers. Past participles that have acquired strong adjectival qualities (usually, they are participles expressing feelings) may be used with "very", for example, "very bored, very interested, very surprised, very tired". Past participles that have strong verbal qualities are used with "much" or "very much", for example, "much obliged, very much appreciated, very much criticized, much reduced". Examples:

I was very tired yesterday.

Your help was very much appreciated.

Her first novel was much criticized.

Her latest novel is much talked about.

Which past participles can be used with "very" and which only with "much" or "very much" is a difficult question. There are no recommended lists of past participles that can be used with "very", and there is no agreement among linguists on this issue. Some linguists allow "very disappointed, very annoyed, very pleased"; others insist on "very much disappointed, very much annoyed, very much pleased".

Generally, use "very", "much" or "very much" with this or that past participle if you saw such use in your textbook and in other educational materials. Avoid frequent use of these intensifiers with participles. This will improve your style and will help you to avoid mistakes.

Note:

The issue described above concerns only the past participle because the present participle is generally not used with "much" or "very much". Whether you can use "very" with this or that present participle depends on the meaning of the participle and on how close to the adjective it has become. For example, you can say "very interesting, very boring, very encouraging, very surprising", but you can't say "very flying, very working".

Participles as adverbial modifiers

Participles in the function of adverbial modifiers (of time, reason, manner, accompanying circumstances, etc.) are usually found in participle constructions, though single participles are also quite possible. The negative particle "not" is placed before the participle. Participle constructions in the function of adverbial modifiers are used mostly in writing.

Participle constructions in the function of adverbial modifiers usually stand at the beginning of the sentence, but may sometimes stand in the middle or at the end of the sentence. Since the action expressed by the participle in such constructions usually refers to the subject of the sentence, the participle in any position in the sentence should be clearly connected with the subject.

Participle constructions in the function of adverbial modifiers of time and reason (usually at the beginning of the sentence) express the same meaning as adverbial clauses of time and reason. In some examples below, corresponding complex sentences are indicated in parentheses.

Present participle as adverbial modifier: Examples

Arriving at the airport, we learned that our flight was delayed because of weather conditions. (When we arrived at the airport, we learned that our flight was delayed because of weather conditions.)

When doing the exercises, look up the new words.

Standing by the window, he watched the people on the street.

Having finished my work, I went home. (After I finished my work, I went home.)

Having seen him in that building before, I thought that he worked there. (As I had seen him in that building before, I thought that he worked there.)

Feeling very tired, she went to bed early. (She went to bed early because she was feeling very tired.)

Not knowing what to expect, she was afraid to open the door.

Laughing, the girls ran out of the classroom.

She sat in the corner, waiting.

He stood by the door, looking at us angrily.

Past participle as adverbial modifier: Examples

Asked to explain what happened, he said that he didn't know. (When he was asked to explain what happened, he said that he didn't know.)

If lost in a new city, call the police. (If you are lost in a new city, call the police.)

Surprised by his strange decision, his friends tried to talk him out of it.

Left in the yard, the books were spoiled by the pouring rain.

Lost in the woods, the dog managed to find the way home.

Cook and stir until thickened. (Cook and stir until the mixture is thickened.)

Dangling participle

Usually, the action expressed by the participle in the function of an adverbial modifier refers to the subject of the sentence.

The term "dangling participle" (unattached participle) refers to the situation in which, because of incorrect sentence structure, the participle is unrelated to the subject or is connected to the wrong noun. For example:

Coming out of the house, the rain started.

Not knowing his telephone, a letter was sent to him.

Dangling participles are considered to be bad style of writing. Besides, they can cause misunderstanding. Sentences with dangling participles should be restructured. It can be done (1) by clearly indicating the subject of the sentence so that the participle is clearly attached to the subject, or (2) by changing the participial construction into a subordinate clause.

For example, the sentences with dangling participles in the examples above can be restructured in the following ways:

Coming out of the house, I saw that the rain started.

When I came out of the house, the rain started.

Not knowing his telephone, we sent a letter to him.

As we didn't know his telephone, we sent a letter to him.

It is necessary to say that dangling participles are rather common in literary works, especially in those cases where the subject is impersonal "It", and where weak connection between the participle and the subject does not lead to ambiguity for the reader. For example:

Going home, it occurred to me that I had probably seen him before.

Nevertheless, it may be advisable for language learners to avoid using such sentences in formal writing, especially in test and examination papers.

Note: Prepositions and conjunctions in the form of participles

Some prepositions and conjunctions are in the form of participles. For example: concerning, considering, including, notwithstanding, owing to, judging from, provided that, regarding, supposing.

They do not require a strict connection with the subject and should not be regarded as dangling participles. The same can be said about participles in such set expressions as "generally speaking, strictly speaking, taking into consideration" and some others. Examples:

Owing to the rain, the game was postponed. Considering the price, this table is a good buy. Strictly speaking, they are not her relatives.

Absolute participle construction

The absolute participle construction has its own subject (to which the action expressed by the participle refers) and can stand at the beginning or at the end of the sentence. Sometimes the preposition "with" introduces an absolute participle clause.

Absolute participle constructions are often used in literary works and scientific writing, but are rare in ordinary speech. In your own speech, you can replace absolute participle constructions with simpler constructions. Examples:

The weather being nice and warm, we went for a walk. (As the weather was nice and warm, we went for a walk.)

Nobody knowing what to do, we decided to do nothing. (Because nobody knew what to do, we decided to do nothing.)

Two of them headed toward the director's office, the other three staying in the hall. (Two of them headed toward the director's office, and the other three stayed in the hall.)

Sydney is the largest city in Australia, with Melbourne being the second largest.

Their recent fight forgotten, the children began to play with their new toys. (The children forgot their recent fight and began to play with their new toys.)

Our work finished, we said good-bye and left.

She listened to his story quietly, with her eyes closed and her face impassive.

Participles in constructions with complex object

In sentences like "I saw him crossing the street. I found him sleeping. I had my car washed.", the constructions "him crossing; him sleeping; car washed" are often called "complex object" in Russian grammar materials.

The term "complex object" is rarely found in English grammar materials. Instead, participles in such constructions are usually called "object complement; objective complement; objective predicate". (See Verbs Glossary of Terms in the section Grammar.)

The use of the infinitive in constructions with complex object is described in The Infinitive in the section Grammar and in the commentary (in Russian) to the song Joe Cocker - N'Oubliez Jamais in the section Hobby.

Present participle in constructions with complex object

Constructions after verbs of sense perception

The present participle is used in constructions with complex object after the verbs of sense perception "hear, see, watch, observe, notice, feel" to indicate the action in progress. For example:

I saw him locking the door. I saw him watching me. I see her smiling.

I heard them laughing. I hear the telephone ringing.

She felt him looking at her. She noticed him smiling at something.

The infinitive in such constructions usually expresses a completed action, but if the verb is of continuing nature, the infinitive can express the action in progress. Compare:

I saw him crossing the street. – I saw him cross the street.

I saw her coming out of the house. – I saw her come out of the house.

I heard the telephone ringing. – I heard the telephone ring.

I heard him singing. – I heard him sing.

I heard her crying. – I heard her cry.

He watched them walking slowly toward the house. / He watched them walk slowly toward the house.

Note:

Note the use of participles after the verbs "smell" and "find":

I smell something burning.

I found him sleeping.

She finds him interesting.

I found the door locked.

Past participle in constructions with complex object

Constructions after "see, hear, want, consider"

The past participle is used in constructions with complex object to show that the person or thing indicated by the object undergoes the action indicated by the participle.

He saw his bags put into the trunk of a large car.

She saw several participants arrested during the demonstration.

We heard her name mentioned during the discussion.

He wants it done as soon as possible.

We want him elected.

I consider this matter closed.

Note: In the last three examples above, the participles "done, elected, closed" may be regarded as shortened variants of the passive infinitive forms "to be done; to be elected; to be closed".

Construction "have something done"

In constructions like "I had it done", the past participle is used after the verb "have" (or after "get" in informal speech) to show that the action is performed for you by someone, usually at your request.

I had my car washed.

He had his hair cut yesterday.

She got her TV repaired.

However, in some cases the action expressed by the participle after the verb "have" in such constructions is performed not at your request, and the action may be unpleasant. Examples:

She had her purse stolen yesterday.

He had his nose broken in a fight.

She got her finger jammed in the door.

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Appendix 3

SUMMARY CLICHÉS

При составлении аннотации можно пользоваться группами клише. Клише делятся на три группы:

1. *Касающиеся общей темы текста.*

The text deals with… - В тексте говорится о…

The article is on… - Эта статья о…

The chapter discusses an important problem of… - В этой главе рассматривается важная проблема…

2. *Выявляющие главную мысль текста, идею.*

The author emphasizes the idea of… - Автор подчеркивает мысль о том…

The main idea of the text is… - Основная мысль текста заключается в том, что…

The author believes… - Автор полагает, что…

He points out that… - Он указывает…

3. Связанные с заключением, к которому автор подводит читателя.

The author comes to the conclusion that… - Автор приходит к выводу..

On reading the article we realize the fact that… - Прочитав статью, мы убеждается, что…

In conclusion the article reads… - В заключении в статье говорится…

ОСНОВНЫЕ ГЛАГОЛЫ, ИСПОЛЬЗУЕМЫЕ В АННОТАЦИИ

to compare	сравнивать	**to explain**	объяснять
to obtain	получать	**to suggest**	предлагать
to apply	применять	**to perform**	выполнять
to employ, to use	использовать	**to differ**	отличаться
to determine	определять	**to require**	требовать
to establish	устанавливать	**to improve**	улучшать

to design	проектировать, конструировать	**to perfect**	совершенствовать
to provide	создавать, обеспечивать		

The following clichés will help you to speak about the contents of any text you've read.

This The	text book article	is about deals with touches upon	(the)… the problem of… the question(s) of…

This			is of presents	much some great no	interest importance use	for those who	study... are interested in
The	problem question subject fact	considered discussed in question under consideration					

The author	points out states makes it clear draws our attention to the fact	that…

It is	necessary interesting important useful	to	bear in mind emphasize mention say	in this connection	that…

There are The author gives	some two (three) many	good and interesting useful	examples illustrating the…

The examples given	in the text by the author	illustrate well enough the…

It should be	realized made clear pointed out borne in mind mentioned	that…

The author arrives at the following conclusions…	To sum up	I'd like to say that

ЗАКЛЮЧЕНИЕ

Это пособие для тех, кто изучает конструирование и технологию электронных средств. Оно является своеобразным вводным курсом в профессию на английском языке.

Цель пособия – развивать навыки чтения и перевода специальных текстов, говорения и письма на английском языке, а также помогать в освоении программы, включающей физику, математику и другие науки.

Тексты знакомят с историей отрасли, основными понятиями электроники, компонентами микроэлектронных систем и процессами проектирования электронных средств на английском языке.

Книги, журналы, сайты, указанные в списке источников, помогут двигаться дальше не только в освоении английского языка, но и профессии.

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